Memory

ISSN: 0965-8211 (Print) 1464-0686 (Online) Journal homepage: https://www.tandfonline.com/loi/pmem20

Reversal of typical processing dynamics in positive and negative priming using a non-dominant to dominant cross-language lexical manipulation

Ewald Neumann & Ivy K. Nkrumah

MEMORY
2019, VOL. 27, NO. 6, 829–840
https://doi.org/10.1080/09658211.2019.1573902

Reversal of typical processing dynamics in positive and negative priming using a non-dominant to dominant cross-language lexical manipulation

Ewald Neumann[a] and Ivy K. Nkrumah[b]

[a]Department of Psychology, University of Canterbury, Christchurch, New Zealand; [b]Department of Educational Foundation, University of Cape Coast, Cape Coast, Ghana, Africa

ABSTRACT
A bilingual primed lexical decision task was used to investigate priming effects produced by attended and ignored words. Participants were required to name prime target words in their weaker (L2) language and then make lexical decisions to probe target items in their dominant (L1) language. Accelerated lexical decisions to probe target words resulted when the word was a translation equivalent of the preceding prime target word, but they were not impaired when the word was a translation equivalent of the preceding ignored nontarget word. This novel finding of a positive priming effect coupled with the absence of a negative priming effect is the opposite pattern of earlier cross-language experiments wherein priming was assessed from L1 to L2 [i.e., Li, Neumann, & Chen, 2017. Identity and semantic negative priming in rapid serial visual presentation streams. *Attention, Perception & Psychophysics*, *79*, 1755–1776; Neumann, McCloskey, & Felio, 1999. Cross-language positive priming disappears, negative priming does not: evidence for two sources of selective inhibition. *Memory & Cognition*, *27*, 1051–1063; Nkrumah & Neumann, 2018. Cross-language negative priming remains intact, while positive priming disappears: evidence for two sources of selective inhibition. *Journal of Cognitive Psychology*, *3*, 1–12]. The present results may be a reflection of altered excitatory and inhibitory dynamics when a weaker, non-dominant language is the source for potential positive and negative priming effects between languages in bilinguals.

ARTICLE HISTORY
Received 1 May 2018
Accepted 16 January 2019

KEYWORDS
Selective attention; bilingualism; language dominance; positive priming; negative priming

For bilinguals parallel language activation appears to be an automatic consequence of knowing more than one language, regardless of what those languages are, whether they share similar or distinct scripts, or how those languages are recruited. Numerous studies have shown that both languages of a bilingual are active when bilinguals perform a given task (e.g., Desmet & Duyck, 2007; Dimitropoulou, Duñabeitia, & Carreiras, 2011; Freeman, Blumenfeld, & Marian, 2016; Li & Gollan, 2018; Mishra & Singh, 2016). Much less is known, however, about how these languages (or the words within them) are independently up- or down-regulated after such parallel co-activation. What is clear is that the bilingual has to choose a specific representation among competing alternatives between the two languages – what Finkbeiner, Gollan, and Caramazza (2006) describe as the "hard problem" for bilinguals. Selecting one language for response is associated with the question of how the nontarget language is controlled to prevent interference. Thus bilingual research addresses the challenge of competition between languages and the words within them.

There is evidence that bilinguals use a sophisticated mechanism of control to inhibit influences from the unintended language during cross-language task performance (Green, 1998; Neumann, McCloskey, & Felio, 1999). Studies that examine event related potentials (ERPs) in bilinguals (Kroll, Bobb, Misra, & Guo, 2008; Wu & Thierry, 2017), and cumulative behavioural studies (Misra, Guo, Bobb, & Kroll, 2012; Neumann et al., 1999; Nkrumah & Neumann, 2018) converge with neurocognitive speculation (Abutalebi et al., 2008; Abutalebi & Green, 2007) regarding inhibitory control as a key underlying mechanism in bilingual language selection and use. Within this framework, selection is achieved by an inhibitory mechanism that suppresses the activation of lexical representations of the current unwanted or nonresponse language. Green's inhibitory control (IC) model predicates three distinct processing dimensions: first, inhibition applied to the lexical nodes of the nonresponse language is "reactive" in the sense that it is only functional after the lexical nodes have been activated and that more active lexical nodes are more strongly inhibited; second, despite this suppression mechanism the lexical nodes of the nonresponse language initially interfere during lexical selection in the response language, because the conceptual system first activates the lexical nodes of the two languages, but those belonging to the nonresponse language are subsequently suppressed; and third, there is discrete

CONTACT Ewald Neumann ewald.neumann@canterbury.ac.nz Department of Psychology, University of Canterbury, Private Bag 4800, Christchurch 8140, New Zealand

processing between lexical and sublexical levels, and phonological activation is restricted to the selected lexical node.

The inhibitory mechanism involved in bilingual language processing has most extensively been explored using priming manipulations. The experimental design of the present study is most closely related to cross-language priming experiments that include attended repetition (AR) and ignored repetition (IR) priming manipulations with translation equivalents across languages (Neumann et al., 1999, Experiment 2; Nkrumah & Neumann, 2018, Experiments 2 and 3). In these experiments, the letter-case of words (i.e., lower-case target, upper-case distractor) provided the selection cue between the target and distractor word in each prime and probe display. In the Neumann et al. experiment participants were required to name prime target words in their dominant L1 (English) followed by making lexical decisions to probe target items in their weaker L2 (Spanish). In contrast with a control condition (CO), in which there was no relationship among the words in the prime and probe displays, the IR condition was impaired resulting in a negative priming effect (for review see Frings, Schneider, & Fox, 2015). Thus, when the probe target word was a translation equivalent of the ignored prime distractor word, there was a *delay* in making the lexical decision, compared to the CO condition. Interestingly, however, no positive priming effects emerged in the AR condition in which the probe target word was a translation equivalent of the prime target word. This pattern of findings was corroborated and extended in the Nkrumah and Neumann (2018) study with Twi (a native language of Ghana) – English bilinguals. By contrast, when the above experiments were conducted within a single language using the L1 of the participants (i.e., English in Neumann et al., 1999, Experiment 1; Twi in Nkrumah & Neumann, 2018, Experiment 1) both positive and negative priming effects were clearly observed.

The explanations posited for the pattern of findings in the above cross-language experiments were that because stimuli were presented in a predictable regularly alternating sequence from one language to the other (i.e., L1 to L2 in every prime-probe couplet), participants could concentrate their upcoming "word" vs. "nonword" decision on those lexical representations belonging to the language of the upcoming target after finishing the response to the prime target. This prospective knowledge enabled global inhibition of the prime target language to prevent it from interfering with the impending task of requiring a response in the other language (i.e., Spanish in the English-Spanish study and English in the Twi-English study). A consequence of such global suppression of the prime language would be the elimination of spreading activation from the prime target to its translation equivalent in the other language, and thus the elimination of positive priming in the AR condition. On the other hand, local inhibition of the prime distractor word would nevertheless impair responding to its translation equivalent word in the other language in the IR condition. These explanations support the proposal that excitation and inhibition are independent resources that can operate simultaneously in selective attention tasks in order to modulate momentarily relevant and irrelevant information (Neumann & DeSchepper, 1992; Neumann & Levin, 2018; Neumann, Cherau, Hood, & Steinnagel, 1993).

Evidence for an inhibitory control account has also been widely reported in language switching experiments (Linck, Schweiter, & Sunderman, 2012; Meuter & Allport, 1999; Wang, 2015). Language switching experiments investigate language selection in bilingual speakers and how language network prioritisation and inhibition is implemented as a function of task requirements and the currently active schema. Such research examines language control and selection processes as well as nontarget language interference avoidance processes that are presumably invoked during cross-language tasks. The experimental protocols typically involve the presentation of stimuli (e.g., pictures or numbers) with participants required to name the stimuli in either their dominant first (L1) or nondominant second (L2) language, unpredictably as determined by a colour cue. The difference in naming latencies between a trial where the response language switches from a previous trial and nonswitching trial is expressed as the *language switching cost*.

Most language switching research has demonstrated asymmetrical switch costs, largely driven by language dominance, such that switches into a more dominant (L1) language incur considerably greater reaction time (RT) delays than the reverse (Filippi, Karaminis, & Thomas, 2014; Klecha, 2013; Macizo, Bajo, & Paolieri, 2012). In the seminal study by Meuter and Allport (1999) bilinguals named numerals in either their dominant L1 language or nondominant L2 language. Response latencies on switch trials (where the response language changed from the previous trial) were slower than on nonswitch trials. They also found that language-switching cost was larger when switching to the dominant L1 from the weaker L2 than vice versa. To account for this pattern of results, they surmised that naming in the weaker language (L2) necessitated active inhibition or suppression of the stronger competitor language L1, and this inhibition persisted into the following (switch) trial in the form of relatively greater temporary impairment in accessing the L1 lexicon.

Extrapolating from these language switching asymmetries, it appears that the order of language presentation determines switch cost, because there is more cost incurred when L2 precedes L1 than vice versa. However, language switching experiments, such as those by Meuter and Allport (1999; see also Kleinman & Gollan, 2018) are very different from the present selective attention paradigm. For one, the language required for naming the current stimulus in their experiments is unpredictably cued by colour coinciding with the onset of the stimulus to be named. This is markedly different from the current task requiring the naming of a target word in the simultaneous presence of a nontarget distractor word followed systematically trial after trial by a lexical decision to a subsequent target word in another language. In this case the participant prospectively knows that there is regular alternation between one language to the other in each prime – probe couplet, whereas the particular language required for any particular stimulus is unbeknownst to the participant in language switching paradigms. Nevertheless, in cross-language experiments the order of prime-probe language presentation could have an impact on the priming effects that are produced, such that priming effects produced when the prime task is in L2 and the probe is in L1 might be different from the reverse. This possibility has recently been observed in an intriguing variant of a negative priming experiment involving rapid serial presentation streams across languages (Li, Neumann, & Chen, 2017, Experiment 4) using Chinese (L1) – English (L2) bilinguals, they observed between language negative priming in the prime – probe direction L1 to L2, but not L2 to L1.

The task used by Li et al. (2017, Experiment 4), however, was very different from the current task. They explored the idea of inhibition using a rapid serial visual presentation (RSVP) paradigm. In this paradigm, participants look at a continuous presentation of visual items presented at around 10 items per second, all of which are presented in the same location, but separated in time. To investigate negative priming in this task the idea was that a stimulus that was a distractor on a previous stream (the prime) becomes the target in the next stream (the probe). The participant's task was to report the identity of the *black* digit target on each trial (i.e., the sequence of events was prefixed by an "@" symbol for ½ second). All other events (i.e., letters and red digits) were distractors that needed to be ignored. In Experiment 4 participants were Chinese-English bilinguals whose dominant language L1 was Chinese and whose L2 was English. The key language order manipulation differed only in the directionality of the dominance of the language used for the prime stream. As such, whereas the L1 to L2 manipulation used Chinese distractors (i.e., the character printed in red) followed by English targets (the black number words), the reverse was true in the L2 to L1 direction.

Participants showed negative priming only in the L1-to-L2 trials, but no evidence of negative priming was observed when the prime distractor was in L2 and the probe target in L1. Li et al. (2017) suggested that this asymmetry reflected differences in activation level between the two languages. By definition, participants were more fluent in L1 than in L2. Consequently, when the prime distractor was in L1, strong inhibition was required to prevent it from interfering with the Chinese prime target word, and a strong negative priming effect resulted when that inhibition impaired responding to its English translation equivalent probe target. By contrast, an L2 prime distractor would be activated relatively weakly, leading to weak inhibition that resulted in negligible and nonsignificant negative priming. These findings were best explained within a distractor-inhibition framework. According to their account, negative priming is a by-product of the target selection process during which the representation of the distractor is inhibited. Depending on the task, distractor inhibition can occur at a physical level or at a semantic level, but the degree of inhibition can be automatically adjusted in response to the potency of the distractor interference via feedback mechanisms. When the distractor in the prime trial becomes the target in the probe trial, the processing of the target is generally delayed relative to a new item. However, the degree of inhibition can be affected by factors such as language dominance. A distractor in a weaker language may not produce enough conflict with a target in that language to produce a significant negative priming effect across translation equivalents. This could account for the absence of negative priming in the L2 to L1 streams. On the other hand, a distractor in a stronger or more dominant language would be relatively more highly conflicting, thus requiring a degree of inhibition that is strong enough to produce negative priming in the L1 to L2 priming condition. Consistent anticipation of high degrees of conflict in an experiment-wide manner is often required to produce significant negative priming effects (e.g., McLennen, Neumann, & Russell, in press; Moore, 1994; Pritchard & Neumann, 2009, 2011). According to inhibition-based theories, this can be caused by the lingering inhibition of the previously suppressed stimulus representation or, according to episodic retrieval theories, by response memories associated with the stimulus whose appearance as a probe target can trigger the retrieval of its prior processing episode in which the representation of the stimulus was inhibited (see Neumann & Levin, 2018).

The study by Li et al. (2017) is the only relevant cross-language selective attention experiment we are aware of that shows the above asymmetrical pattern and thus provides the primary source for our current hypotheses regarding contrasting predictions about negative priming that are dependent on language dominance manipulations from prime to probe (see also Duscherer & Holender, 2002). The current experimental design, however, is a direct modification of Experiment 3 in Nkrumah and Neumann's (2018) study in which the prime words were in L1 (Twi) and the probe target and distractor were in L2 (English). The crucial difference is that in the current experiment the prime display words were now in the participant's L2 (English), while preserving their upper- and lower-case status, and the probe target and distractor words were in their L1 (Twi). Because translation equivalents of the word stimuli used in Nkrumah and Neumann's Experiment 3 were used, it insured that these experiments were virtually identical, except for the language dominance manipulation. That is to say, the current experiment is designed so that any AR, CO, and IR effects are specifically derived from priming effects going from L2 to L1, instead of L1 to L2, with all other stimuli, apparatus, presentation parameters, etc. held constant with the earlier cross-language experiment. Because no previous experiment has investigated priming effects in this specific language dominance arrangement of cross-language priming, specific a priori hypotheses are not easy to derive. The switching experiments discussed earlier suggest that asymmetries can occur that are dependent on language dominance factors. Of particular interest are the findings from Li et al.'s (2017) RSVP negative priming experiments showing negative priming does not occur from L2 to L1 in the same task conditions in which it clearly occurs from L1 to L2. The overarching goal is therefore to examine whether similar priming effects to the ones observed in the previous L1 to L2 cross-language experiments (Neumann et al., 1999, Experiment 2; Nkrumah & Neumann, Experiments 2 and 3) would emerge when the potential priming effects proceed from the less dominant L2 language to the more dominant L1 language. A similar outcome may be plausible in light of using an identical task, but with the exception of using the weaker, instead of stronger, language in the prime component of the task, and the stronger, instead of weaker, language in the probe component of the task. On the other hand, if the findings of Li et al. (2017, Experiment 4) are conceptually replicated, despite using a very different task, we would expect the cross-language negative priming effects observed by them in the L1 to L2 direction to be eliminated in the L2 to L1 direction. In addition, the outcome should provide useful hints not only about the role of language dominance on the mechanisms that modulate negative priming effects between languages in bilinguals in this type of selective attention task, but also potential facilitatory priming, since this experiment is the first of its kind to investigate attended repetition positive priming across languages in the L2 to L1 direction.

Contrasting the current AR positive and IR negative cross-language priming outcomes in the L2 to L1 direction with our earlier cross-language priming experiments in the L1 to L2 direction, allows us to draw theoretical and empirical parallels and differences between excitatory and inhibitory mechanisms. The primary aim is to begin to isolate the circumstances in which these mechanisms operate in a selective attention situation requiring bilingual language and lexical modulation when the priming language is the weaker (L2) language.

A conceptual replication of Li et al. (2017, Experiment 4) would be evidenced by an absence of IR negative priming when the priming proceeds from L2 to L1. The implication here would be that when the prime language (L2) is the weaker language, the competition from the distractor word in that language would not be strong enough with the target word to elicit the degree of inhibition required to produce and IR negative priming effect (see Li et al., 2017).

When the potential for AR priming proceeds from L1 to L2, Nkrumah and Neumann (2018) posited that bilinguals employ a global form of inhibition to suppress the potential interference from the stronger, more dominant language L1 (Twi) in the prime when it becomes irrelevant for a response requiring L2 (English). This led to the complete absence of AR positive priming for translation equivalents in their study. When the potential for AR priming proceeds from a weaker to a stronger language (L2 to L1), however, the processing dynamics should change (e.g., Chen & Ng, 1989; Frenck-Mestre & Prince, 1997; Lijewska, Ziegler, & Olko, 2016). In this case, bilinguals might be inclined to rely on their native language (Twi) as a type of crutch when accessing their second language (English) in the prime display. As such, implicit translation from the English word to its Twi counterpart would take place during target prime word processing, and should thus produce AR facilitatory priming across these translation equivalents from prime to probe.

Methods

Participants

Thirty-three Twi-English bilinguals (23 men and 10 women) from the Foso College of Education in Ghana voluntarily participated. All the participants had normal or corrected to normal colour vision. They ranged in age from 19 to 30 with an average age of 22 years. The participants were all native speakers of the Twi language who subjectively rated themselves to be proficient in their second (English) language. Notably, English is taught to school children in Ghana beginning at age six and university courses are taught solely in English. The participants all reported regular and deliberate communication in both Twi and English languages on a daily basis.

Stimuli

The stimuli were 620 three to thirteen letter common words that adults would know. Their corresponding Twi noncognate equivalent translations were chosen from the Twi-English, English-Twi *Hippocrene Concise Dictionary* (Kotey, 2007). Ninety-six pronounceable Twi nonwords were also generated to cater for the nonword conditions [e.g., *mpɛtɛɛ* – instead of *mpataa* (meaning fish in English)]. There were approximately equal numbers of letters in letter strings for the word and nonword targets, in order to curtail ease of discriminability between targets and distractors. One-hundred and sixty-eight items from the word pool were used as targets, and the rest as filler words. Three priming conditions were created: (AR) – in which the probe target (Twi word) was the English translation equivalent of the prime target word [e.g., pen (meaning *twerɛdua* in Twi) ~ *twerɛdua*]; (CO) – in which prime and probe stimuli had no relationships, [e.g., stick (meaning *dua* in Twi) ~ ɔbɔfoɔ (meaning *hunter* in English)] and (IR) – in which the target probe Twi word was the translation equivalent of the ignored prime English word [e.g., NEEDLE (meaning *paneɛ* in Twi)

~ *paneɛ*]. See Table 1 for a sample of the conditions in the experiment.

The experiment contained 72 word (24 each of AR, CO, and IR trials) and 72 nonword trial couplets. There was a low ratio of AR trials (24 total trial couplets) because evidence shows that as relatedness proportion increases, participants are apt to create expectancies to boost performance (Neely, 1991). Two hundred and sixteen Twi words from the stimulus pool were divided into 72 each of prime distractors, probe distractors and probe targets. The 72 probe target words were randomly distributed into sets A, B and C of 24 words in each of the three conditions (AR, CO, and IR). Participants were randomly assigned to these groups for the purpose of counterbalancing. The word and nonword trial couplets were randomised and the same order appeared for all participants irrespective of the counterbalancing group. Our manner of counterbalancing adheres to the important recommendations by Duscherer and Holender (2002), but are even more rigorous. For example the present counterbalancing of the stimuli would have made it highly unlikely for the experiment conditions to be biased by particular items. More specifically, the experiment had 3 conditions (AR, CO, and IR) and the way items were counterbalanced across participants insured that each target probe word in the AR condition was also the target probe word in the Control condition in another version, and was also the target probe word in the IR condition in the remaining version. According to the SUBTLEX word frequency database (Brysbaert & New, 2009), these probe targets have a mean word frequency count of 72.60 per million words (see also Appendix A in Nkrumah & Neumann, 2018, for a list of these English words and their Twi translations). Filler words were also the same as those in the Nkrumah and Neumann (2018, Appendix B) study. Everything else in the task was held constant across participants. Thus if, for example, the target probe word was the Twi translation of the word "stick" on the 28th trial in the AR condition in version A, the translation of "stick" would also have been the target probe word in the 28th trial in the Control condition in version B, and would also have been the target probe word in the 28th trial in the IR condition in version C. This goes beyond normal counterbalancing procedures, because not only are the items on which RTs are collected perfectly counterbalanced, they also occur in exactly the same trial sequence and are partnered with the same filler items across participants for all of the conditions. This nullifies the potential item effects that have plagued earlier negative priming studies that have used word stimuli (for details see Duscherer & Holender, 2002; Henson, Eckstein, Waszak, Frings, & Horner, 2014).

Each target or distractor word appeared once in a prime-probe display except to satisfy the AR and IR conditions. In order to eliminate bias toward responding "word" or "nonword", there were equal numbers of word and nonword trials. None of the priming manipulations were used in the nonword condition. Twenty-four practice trial couplets preceded the main experiment. No practice word was repeated in the main experiment. Importantly, the stimuli, as well as the methodology, were specifically designed to emulate the protocol of Experiment 3 in Nkrumah and Neumann's (2018) study. The main difference was to move all of the probe displays that included words into the position of the prime displays and vice versa, thereby recreating the exact same AR and IR priming conditions, but this time in the L2-to-L1 direction, instead of L1-to-L2 direction. In this way any change in the pattern of findings between these experiments cannot be attributed to the word pool, apparatus, or any other methodological change.

Table 1. Sample of conditions for word/nonword trials in the experiment.

Condition	Prime display	Probe display
Attended repetition	truth	nokware
	TELEPHONE	GYIDIE
Control condition	book	ɔKYEAME
	BOTTLE	asɛm
Ignored repetition	CUP	kuruwa
	profession	SAFOA
Nonword condition	table	abofrɔ
	WISDOM	ADWENE

Note: Lowercase letters in each case were the targets and the uppercase letters were distractors. Lowercase words in the prime display required naming, lowercase words in the probe display required a lexical decision. Only word trials were analysed.

Apparatus and stimulus presentation

Stimuli were presented on a 15.6 inch Hewlett-Packard (HP) laptop computer using E-Prime 2.0 software programme (Psychology Software Tools, Inc.). A 5-button PST Chronos response box (Psychology Software Tools, Inc., 2012) was used for recording lexical decision RTs. The two leftmost buttons were activated and labelled "word" and "nonword". A response sheet was created with prime target words to enable the experimenter to monitor the naming of primes for later extraction of trials on which naming errors were committed. All word stimuli were printed in lowercase (target) and uppercase (distractor) black letters (Calibri, font size 11) on a white background. Target and distractor items were displayed one above the other pseudorandomly such that they each appeared at the top 50% of the time and at the bottom 50% of the time across all conditions. Nonword letter strings served only as probe targets. The width of the words covered approximately 1.4 cm (1.6 degrees of visual angle) for the shortest to 5 cm (5.7 degrees of visual angle) for the longest. The distance between the closest edges of the top and bottom letter string was 1 pixel width. Prime displays were presented either centre, or slightly to the left or right of centre, in equal proportions on the computer screen. This spatial uncertainty tends to augment the magnitude of NP by taxing attentional selectivity and thereby concentrating the state of focal attention (McLennen et al., in press; Neumann & DeSchepper, 1991; Pritchard &

Neumann, 2011). Probe stimuli were displayed at the centre of the screen at all times.

Design and Procedure

The experiment was carried out in an isolated, dimly-lit room optimised for low noise. Participants were tested individually in a session lasting about 55 min. They sat at an approximate viewing distance of 50 cm from the computer screen. The task started with 24 practice trial couplets including all four possible experimental conditions (AR, CO, IR, and nonword trials). They were instructed to say aloud, as quickly and accurately as possible the lowercase prime target word while ignoring the uppercase distractor word. Then in the probe display, decide whether the lowercase probe target was a correct Twi word or not. Participants were guided through the practice trials and provided with feedback on accuracy after each practice trial.

Each trial began with a black fixation cross displayed for 500 ms, followed by the prime stimuli that stayed on the screen for 250 ms, followed by a blank display screen for 1000 ms, while the participant named the prime target word. The probe stimuli were then displayed on the screen until the participant made a lexical decision to the probe target item. Lexical decisions to probe targets were made by pressing the "word" button with the index finger of the right hand, and the "nonword" button with the middle finger of the right hand. RTs were collected from the onset of the probe display until a button was pressed. Once a response was registered, the next trial began (see Figure 1).

To summarise the main manipulations, each trial couplet had an English (L2) prime display which had a target word and a distractor word in English and a Twi (L1) probe display which had a target word and a distractor word in Twi. Participants named the target word in the prime display aloud and made a lexical decision to the target word in the probe display. Word trials were of three types: (1) AR trials in which the prime target word was a translation equivalent of the subsequent probe target word; (2) CO trials in which the prime words were unrelated to the probe words; and (3) IR trials in which the prime distractor word was the translation equivalent of the subsequent probe target word (see also Table 1).

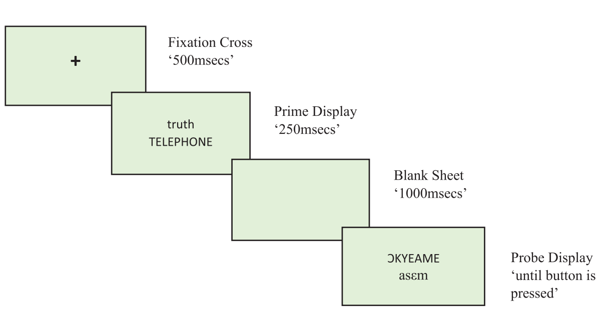

Figure 1. Sequence of stimuli presentation. Note that the distance between the closest edges of the top and bottom item in each display was 1 pixel width.

A supplementary power analysis using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) was also conducted. With the present number of participants tested, the statistical power to detect a medium effect size was just under 80%.

Results

As in the prior study by Nkrumah and Neumann (2018, Experiment 3), individual data sets that contained 30% or above naming or response errors were excluded from analysis. One subject was removed from further analysis based on this criterion. Nonword data were not analysed. A one way analysis of variance (ANOVA) was conducted on the mean RT data with the priming conditions (AR, CO, IR) as the within-subjects factor. A significant effect was found [F (2, 62) = 3.89, MSE = 163414.69, p = .03, η_p^2 = .11]. In order to isolate the source of the priming effect, two two-tailed t-tests for dependent means were conducted separately. The first compared the AR condition to the CO condition and the second compared the IR condition to the CO condition. The AR condition (M = 3413, SD = 929.54) produced significantly faster RTs than the CO condition (M = 3645, SD = 1146.01), t (31) =2.35, p =.01, d =.42. However, there was no difference between the IR condition (M = 3667, SD = 1057.06) and the CO condition (M = 3645, SD = 1146.01), t (31) = .21, p =.42, d = .04. These patterns in the statistical analyses of the RT data are depicted in Figure 2 and further corroborated by the error data analyses below.

Error rates were analyzed in a similar manner. The main effect of priming was significant [F (2, 62) = 4.36, MSE = 16.95, p = .02, η_p^2 = .12]. T-tests again showed significant facilitation in the AR condition (M = 2.89, SD = 3.63) compared with the CO condition (M = 5.64, SD = 4.53), t (31) = 2.61, p = .01, d = .46, indicating fewer errors in the AR condition. Moreover, there was no difference between IR condition (M = 5.39, SD = 5.97) and the CO condition (M = 5.64, SD = 4.53), t (31) = .31, p =.38, d = .05. Hence, there were no speed-accuracy trade-offs in the error results that could compromise the interpretation of the RT results. Indeed,

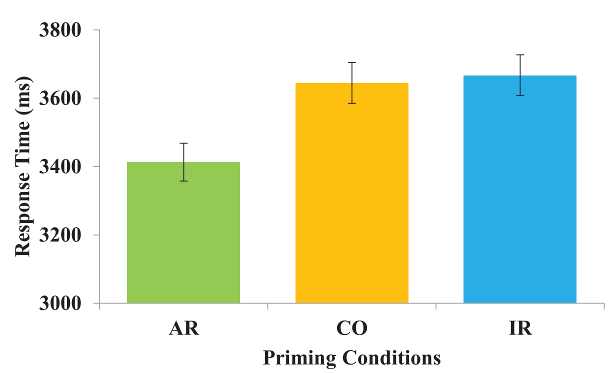

Figure 2. Mean response latency (in milliseconds) as a function of attended repetition (AR), control (CO), and ignored repetition (IR) conditions. Error bars indicate standard errors.

the error data analyses were completely consistent with the RT analyses, again showing significant facilitatory priming in the AR condition compared to the CO condition, with no hint of an impairment in the IR condition compared to the CO condition.

Because the current pattern of results contrasts radically with the earlier study by Nkrumah and Neumann (2018, Experiment 3), additional analyses were conducted using "Experiment" as a between-subjects factor. Recall that in the earlier experiment when the language dominance manipulation was in the L1 to L2 direction the RT analyses showed IR negative priming for translation equivalent words in the complete absence of AR positive priming across translation equivalents. By contrast, in the current experiment when the language dominance manipulation was in the L2 to L1 direction the opposite pattern emerged whereby the RT analyses showed AR positive priming across translation equivalent words in the absence of IR negative priming for translation equivalents. Hence, the current analyses attempted to determine if there was an interaction effect involving "Experiment" for either AR positive priming or IR negative priming across translation equivalent words as a function of language dominance. In either case, a significant interaction would indicate that the two patterns of priming function differently in potentially important ways.

We first conducted a two-way ANOVA on the mean RT data with priming condition (AR vs. CO) as the within-subjects factor and language dominance (L1 to L2 vs. L2 to L1) as the between subjects factor. A significant effect of language dominance was found [F (1, 74) = 4.97, p = .036, η_p^2 = .058] indicating that lexical decisions were made faster in the L1 to L2 condition (i.e., Twi to English) than in the L2 to L1 condition (i.e., English to Twi). A significant effect of priming condition was also obtained [F (1, 74) = 5.81, p = .018, η_p^2 = .073] indicating that lexical decisions were made faster overall in the AR condition, compared to the CO condition. More crucially, there was also a significant interaction effect between language dominance and priming [F (1, 74) = 5.06, p = .027, η_p^2 = .064] indicating that the significant AR positive priming effect was solely a consequence of L2 to L1 language dominance.

Next we conducted similar analyses contrasting the IR versus CO condition. Specifically, we conducted a two-way ANOVA on the mean RT data with priming condition (IR vs. CO) as the within-subjects factor and language dominance (L1 to L2 vs. L2 to L1) as the between subjects factor. A significant effect of language dominance was found [F (1, 74) = 4.23, p = .043, η_p^2 = .054] indicating that lexical decisions were made faster in the L1 to L2 condition than in the L2 to L1 condition. A marginally significant effect of priming condition was obtained [F (1, 74) = 3.23, p = .076, η_p^2 = .042] suggesting that lexical decisions were made more slowly overall in the IR condition, compared to the CO condition. There was also a marginally significant interaction effect between language dominance and priming [F (1, 74) = 2.81, p = .098, η_p^2 = .037] suggesting that the IR negative priming effect was due to the L1 to L2 direction of language dominance. Because these supplementary analyses were more clear-cut with regard to the AR versus CO priming and language dominance interaction effect, the theoretical significance of that interaction will provide a key focus for the discussion section.

Discussion

A cross-language naming and lexical decision task was used to examine the priming effects of attended and ignored words, whereby participants executed prime naming in their L2, followed by making a lexical decision to probe target words in their L1. The experiment was an L2 to L1 reversal of Experiment 3 in Nkrumah and Neumann (2018), which required participants to name prime words in their dominant L1 and subsequently make lexical decisions to probe target items in their weaker L2. The aim was to ascertain whether the priming effects reported in that preceding cross-language experiment were modulated by the order of prime-probe language dominance manipulations. This was clearly the case. When the priming manipulation proceeded from L1 to L2 (Nkrumah & Neumann, 2018, Experiment 3) significant IR negative priming was produced for translation equivalent words in the complete absence of AR positive priming for translation equivalent words. Crucially, the fact that significant IR negative priming was produced suggests that AR positive priming should also have been observed, if there was such an effect. When the priming manipulation proceeded from L2 to L1 in the current experiment, however, only significant AR positive priming was produced for translation equivalent words in the complete absence of IR negative priming for translation equivalent words. Because AR positive priming was produced it suggests that IR negative priming should also have been capable of being observed, if such an effect were present. This is especially the case, since only IR negative priming is produced in this type of experiment when the language dominance manipulation is in the L1 to L2 direction (i.e., Neumann et al., 1999; Nkrumah & Neumann, 2018).

Similar to the preceding cross-language experiments by Neumann et al. (1999) and Nkrumah and Neumann (2018), prime and probe displays in the present study followed a formulaic constant alternating pattern from one language to the other. Hence it was possible that if the language dominance reversal manipulation (L2 to L1, instead of L1 to L2) has no bearing on the outcome, then after participants had reacted to the prime target (English) word, the English language system would become irrelevant and be suppressed. This would allow participants to focus their impending "word" vs. "nonword" judgement on those lexical candidates belonging to the forthcoming target language (Twi). In other words, if this form of processing had been instantiated, as in the earlier L1 to L2 experiments (Neumann et al., 1999; Nkrumah & Neumann, 2018), globally suppressing the English language in the current experiment should reduce or prevent the potential spread of activation from the prime (English) target to its translation equivalent the probe target in Twi, and thus eliminate positive priming. It was also possible that the prime distractor English word would be competitive enough with the English target word to be locally inhibited during the naming of the target. If this were the case, inhibition would spread via spreading inhibition to its translation equivalent in the other language (Twi), and this would impair response to that word if it appeared as the probe target as discussed in our previous cross-language experiments.

As discussed above, however, results showing potentially significant NP effects coupled with the absence of positive priming were *not* obtained in the current experiment. Indeed, the observed pattern is in direct opposition to the previous experiments that have included AR and IR priming manipulations with translation equivalents across languages. The AR facilitation coupled with null IR effects are also incompatible with all of the existent within language experiments, using this paradigm (i.e., both prime and probe in L1 English (Neumann et al., 1999, Experiment 1)); both prime and probe in L1 Twi (Nkrumah & Neumann, 2018, Experiment 1); both prime and probe in L1 English with English monolinguals (Neumann, Nkrumah, & Chen, 2018, Experiment 1); and both prime and probe in L2 English with Twi-English bilinguals (Neumann et al., 2018, Experiment 2). Each of these within-language experiments produced both AR positive and IR negative priming. As long as only one language is required, it is clearly the case that both types of priming occur. These findings help dispel one of the myths about negative priming involving the idea that negative priming with word stimuli only occur when a small pool of recycled words are used (see discussion in Neumann et al., 2018).

In the present study, instead of the patterns of findings discussed above, the AR condition showed substantial positive priming, but no IR negative priming was observed. This replicates the absence of negative priming observed by Li et al. (2017, Experiment 4), wherein priming proceeded from L2 to L1, and adds the new finding that AR positive priming is observable in cross-language priming experiments, as long as the language dominance manipulation is in the L2 to L1 direction. In the supplementary analyses used to determine whether there was an interaction of priming condition (AR vs. CO) with "Experiment" (L1 to L2 vs. L2 to L1), an interaction effect was observed. The significant interaction involving the AR positive priming effect helps corroborate the claim that L1 to L2 positive priming is less than L2 to L1 positive priming. This also provides more compelling evidence that the two directions of priming function differently than simply showing it is significant in the present experiment, but absent in Nkrumah and Neumann's Experiment 3 (2018).

Although not as conclusive, in the supplementary analyses testing whether there was an interaction of priming condition (IR vs. CO) with "Experiment" the marginally significant interaction effect lends evidence suggesting that L1 to L2 negative priming is greater than L2 to L1 negative priming. The implication here is again that the two directions of priming function differently than simply showing negative priming is nonsignificant in the present experiment, but significant in Nkrumah and Neumann's Experiment 3 (2018).

As such, the experiment that is likely to be most revelatory in providing at least a partial explanation for the above cross-language outcomes is Li et al.'s (2017) Experiment 4 using the RSVP-NP task, where IR negative priming was found only in L1 to L2, but not in the L2 to L1 priming direction. It is noteworthy that the L1 to L2 pattern of significant negative priming is completely consistent with all of the cross-language experiments using the present paradigm, as discussed earlier. Furthermore, the absence of negative priming in the L2 to L1 manipulation of the RSVP-NP experiment converges with the inability to observe that effect in the current experiment, which suggests a commonality in the processes involved.

In the cross-language experiments where prime-probe manipulations followed a dominant L1 to a weaker L2 order, the substantial NP effect obtained was attributed to spreading inhibition from the prime distractor (L1 word) to its translation equivalent, the probe target (L2 word). Because participants are more familiar with L1 than L2, the activation of L1 words should be greater than the activation of L2 words. Given that the activation of words in L1 is stronger, greater inhibition would need to be applied to the prime distractor in the L1-to-L2 trials than L2-to-L1 trials. Consequently, there should be a greater likelihood of obtaining negative priming, due to greater competition (conflict) between target and distractor words, in the former than the latter conditions. This pattern of results is collectively consistent with all of the L1-to-L2 cross-language findings to date using the current selective attention task. These results support the contention that negative priming is the result of a flexible reactive suppressive process capable of adjusting to the degree of inhibition in accordance with the amount of distractor interference in the prime trial (e.g., Houghton & Tipper, 1994; Neumann et al., 2018; Wyatt & Machado, 2013). Although naming the prime (L2) target word in the present experiment required inhibition of the concurrently presented (L2) distractor word, ignoring this relatively weak English (L2) distractor did not result in the degree of suppression required to produce significant negative priming (see Neumann et al., 2018). Apparently, in this context, a weak distractor requires relatively little inhibition (Li et al., 2017). Therefore, it is possible that the amount of inhibition applied to the prime distractor (L2 word) was not robust enough to persist and impair responding to its Twi (L1) translation equivalent.

It thus appears that the strength of the prime distractor language has a significant influence on inhibitory control and in eliciting NP effects in cross-language experiments. Distractor words from a dominant L1 language are potentially more interfering, and receive stronger inhibition. The strong inhibition is able to spread to its translation equivalent in the L2 language and elicit NP on IR trials. However, distractor representations of a relatively weaker L2 language receive less inhibition. The weak inhibition is unable to spread and suppress its translation equivalent in the dominant L1 language. Thus, the more strongly a distractor is activated, the more interfering it is and the greater the amount of inhibition it receives. This high level of inhibition causes significant negative priming.

Another anomalous finding that must be accounted for is the finding of AR positive priming across languages when priming occurs from L2 to L1. This finding contrasts with previous cross-language experiments which failed to produce AR positive priming across translation equivalents, in experiments that nevertheless produced IR negative priming across translation equivalents (Neumann et al., 1999, Experiment 2; Nkrumah & Neumann, 2018, Experiments 2 and 3). Hence, this is the first cross-language experiment that has produced significant AR positive priming across-languages. Unfortunately, because the RSVP-NP task discussed earlier did not include an attended repetition manipulation, it provides no basis for prediction or speculation. From our perspective, it may be that since the prime target word is in the weaker language, participants could be more reliant on translating it into its translation equivalent in the dominant language; or similarly L2 words may need little inhibition in order to process L1 words, because L1 words rapidly become more active than L2 words. If that were the case, it could account for the current positive priming effect across languages, since the probe target is the translation equivalent of the prime target in the AR condition. Others have posited such overt translation processes to accommodate positive priming effects with singularly presented prime and probe stimuli using translation equivalents from L2 to L1, in the context of the same task that does not produce positive priming in the L1 to L2 direction (e.g., Chen & Ng, 1989; Duyck & Warlop, 2009; Dimitropoulou et al., 2011; Lijewska et al., 2016; Schoonbaert, Duyck, Brysbaert, & Hartsuiker, 2009).

The current experiment taken collectively with our earlier within- and cross-language paradigms shows that AR positive priming and IR negative priming are clearly capable of being produced with a large pool of nonrecycled words, as long as prime and probe words are within the same language (Neumann et al., 1999, 2018; Nkrumah & Neumann, 2018). As mentioned this helps dispel a common assumption about negative priming with words as the stimuli that the effect is larger and more likely to be observed when a small pool of recycled words is used (Grison & Strayer, 2001; Kramer & Strayer, 2001; Malley & Strayer, 1995; Strayer & Grison, 1999). The current results, along with seemingly contrary findings like Strayer and colleagues' and our contrast between L1-to-L2 in comparison to L2-to-L1 findings, all help to elucidate some of the many sorts of task parameters that can modulate the manifestation of negative priming effects and highlight the importance of replicating processing patterns using different manipulations (Levin & Neumann, 1999; Neumann & Levin, 2018). Another important finding is the absence of AR positive priming across translation equivalents, despite finding IR negative priming across translation equivalents (Neumann et al., 1999; Nkrumah & Neumann, 2018) when the priming manipulation is from L1-to-L2. Those findings clearly support the inhibition-based approach for explaining negative priming effects in a situation in which potential alternative mechanisms are overridden (Li et al., 2017; McLennen et al., in press; Neumann et al., 2018).

The surprising reversal of AR and IR priming effects when the prime-probe relationship changes from L1 to L2 couplets to L2 to L1 couplets suggests intriguing asymmetries in the amount of inhibition applied to momentarily irrelevant, distracting information. At the local word level, the inhibition required to supress an entrenched dominant L1 word to enable L2 processing should arguably be far more than would be required to inhibit an L2 word to enable L1 processing. Hence, the minimal inhibition of the L2 prime distractor word appears to have not even reached a threshold degree of suppression required to produce significant IR negative priming to its cross-language L1 translation equivalent. At the global language level, the inhibition required to supress the dominant L1 language to enable L2 processing is far more than would be required to inhibit an L2 language to enable L1 processing. Hence, the minimal global inhibition of the L2 prime language enables the prime target word to produce significant AR positive priming to its cross-language L1 translation equivalent.

The divergent findings described above illustrate the degree to which cross-language processing dynamics can change in the context of tasks with a selective attention component (Li et al., 2017; Neumann et al., 1999; Neumann et al., 2018; Nkrumah & Neumann, 2018). Because language access in bilinguals undoubtedly requires highly efficient selective attention abilities, it seems remarkable that so few studies in the bilingual research domain involve selective attention manipulations. Perhaps nowhere are such abilities more prevalent and necessary than in bilinguals who use both of their languages on a regular basis. To accommodate the full pattern of different AR and IR outcomes in our experiments, for example, it is necessary to postulate the flexible adjustment of local and global inhibitory control based on changing environmental demands, such as L1-to-L2 vs. L2-to-L1 priming manipulations. Because numerous researchers have shown that there is parallel co-activation of lexical items whenever a bilingual speaks or identifies a word (e.g., Costa, Caramazza, & Sebastian-

Galles, 2000; Kroll et al., 2008; Li & Gollan, 2018), attentional selectivity must come into play. By incorporating a selective attention component in the task, experiments like ours can begin to reveal the degree to which cross-language processing dynamics change as a function of language dominance. As such, this type of investigation can address the fundamental mechanisms bilinguals engage to modulate their languages and the words within them in a unique and flexible way.

For example, taken together with our earlier cross-language priming studies (Neumann et al., 1999; Nkrumah & Neumann, 2018), these collective findings may provide new ways of testing and potentially shedding light on the neurobiological role of GABAergic metabolism in inhibitory processing. In this regard, Schmitz, Correia, Ferreira, Prescot, and Anderson (2017) recently investigated the role the hippocampal GABA neurotransmitter has in the neural inhibition of unwanted memories. They showed the key role GABAergic inhibition of hippocampal retrieval activity plays in the volitional inhibitory control responsible for the suppression of memory content. Their evidence for the GABAergic inhibition of local hippocampal activity provides a neurobiological framework for the inhibitory activity behind the current results, contrasted with those posited by Neumann et al. (1999) and Nkrumah and Neumann (2018). If the stipulations about two sources of inhibition modulating the priming effects are correct in those studies, GABAergic inhibition effects should be detectable in those cross-language selective attention paradigms on an almost trial-by-trial basis. Intensive pursuit of these behavioural and neurobiological findings could thereby provide a fruitful path for advancing one of the main goals of Cognitive Science articulated by Pylyshyn (1984), which is to establish genuine information processing mechanisms closely aligned with the actual biophysiological mechanisms of the brain.

In addition, this framework could provide a new avenue for exploring the viability of the two main theories of negative priming phenomena: inhibition-based and episodic retrieval (Frings et al., 2015). These two theories often make similar predictions in positive and negative priming tasks in spite of the very different underpinning mechanisms they posit (McLennen et al., in press; Neumann & Levin, 2018). Inhibition accounts explain positive and negative priming based on the persistence of attentional activation and inhibition applied to previous targets and distractors influencing subsequent encounters with these targets and distractors or closely related information. Episodic retrieval accounts, however, explain positive and negative priming as the automatic elicitation from memory of the most recent previous encounter with a stimulus that is identical or similar to the stimulus cued by the probe target item. This retrieval results in positive priming if the previous stimulus was a target and negative priming if it was a distractor due to the matching or mismatching of episode response codes. It is noteworthy that only the inhibition-based account would engage the suppressive role of hippocampal GABA in the ways envisioned by Schmitz et al. (2017; for discussion see Neumann et al., 2018).

Conclusion

Using translation equivalents in bilinguals' two languages, the present experiment reported positive priming effects in the absence of negative priming effects, for the first time, when performing the task in the direction of a prime stimulus in their less dominant L2 to a translation equivalent probe target word in their more dominant L1. Consistent with the findings of Li et al. (2017), no evidence of cross-language negative priming was observed when the prime distractor was in L2 and the probe target in L1. Notably Li and colleagues found that cross-language negative priming did occur in the L1-to-L2 trials, as in our previous studies (Neumann et al., 1999; Nkrumah & Neumann, 2018). From our perspective, this asymmetry reflects differences in the latent activation level between the two languages. Consequently, when the prime distractor is in the more fluent L1, strong inhibition is required to prevent it from interfering, and a strong negative priming effect resulted when that inhibition spread to its translation equivalent concept, thus impeding the response to the subsequent probe target. By contrast, a less fluent L2 prime distractor would be activated relatively weakly, leading to weak inhibition that can account for the negligible negative priming reported here. These findings replicate and substantially extend the work of Li et al. (2017), suggesting that the order of language dominance in prime-probe language manipulations influences both negative and positive priming effects in cross-language studies. In addition, the picture emerging from this work in combination with previous within- and cross-language experiments (Neumann et al., 1999, 2018; Nkrumah & Neumann, 2018) is that both AR positive priming and IR negative priming are both clearly capable of being produced with nonrecycled words, as long as prime and probe words are within the same language. By contrast, cross-language negative priming is obtained in the absence of positive priming in the L1 to L2 direction, whereas the opposite is the outcome (i.e., positive priming in the absence of negative priming) in the present L2 to L1 priming manipulation. This research strongly suggests that excitatory and inhibitory control of momentarily relevant target and irrelevant conflicting information, respectively, are important and ubiquitous mechanisms exerting degrees of influence in ways that ultimately dictate patterns of priming effects in these within- and across-language selective attention studies.

Acknowledgments

We are grateful to Jonathan Wiltshire and Paul Russell for their help programming the experiments and to Kristin McLennen for providing data tabulation support.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

Abutalebi, J., Annoni, J., Zimine, I., Pegna, A. J., Seghier, M. L., Lee-Jahnke, H., & Khateb, A. (2008). Language control and lexical competition in bilinguals: An event-related fMRI study. *Cerebral Cortex*, *18*(7), 1496–1505.

Abutalebi, J., & Green, D. (2007). Bilingual language production: The neurocognition of language representation and control. *Journal of Neurolinguistics*, *20*(3), 242–275.

Brysbaert, M., & New, B. (2009). Moving beyond Kucera and Francis: A critical evaluation of current word frequency norms and the introduction of a new and Improved word frequency measure for American English. *Behavior Research Methods*, *41*(4), 977–990.

Chen, H. C., & Ng, M. L. (1989). Semantic facilitation and translation priming effects in Chinese-English bilinguals. *Memory and Cognition*, *17*(4), 454–462.

Costa, A., Caramazza, A., & Sebastiain-Galles, N. (2000). The cognate facilitation effect: Implications for models of lexical access. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *26*(5), 1283–1296.

Desmet, T., & Duyck, W. (2007). Bilingual language processing. *Language and Linguistics Compass*, *1*(3), 168–194.

Dimitropoulou, M., Duñabeitia, J. A., & Carreiras, M. (2011). Two words, one meaning: Evidence of automatic co-activation of translation equivalents. *Frontiers in Psychology*, *2*, 1–20.

Duscherer and Holender. (2002). No negative semantic priming from unconscious flanker words in sight. *Journal of Experimental Psychology: Human Perception & Performance*, *28*, 839–853.

Duyck, W., & Warlop, N. (2009). Translation priming between the native language and a second language: New evidence from Dutch-French bilinguals. *Experimental Psychology*, *56*, 173–179.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*, 175–191.

Filippi, R., Karaminis, T., & Thomas, M. (2014). Language switching in bilingual production: Empirical data and computational modelling. *Bilingualism: Language and Cognition*, *17*(2), 294–315.

Finkbeiner, M., Gollan, T. H., & Caramazza, A. (2006). Lexical access in bilingual speakers: What's the (hard) problem? *Bilingualism*, *9*(2), 153–166.

Freeman, M. R., Blumenfeld, H. K., & Marian, V. (2016). Phonotactic constraints are activated across languages in bilinguals. *Frontiers in Psychology*, *7*. doi:10.3389%2Ffpsyg.2016.00702

Frenck-Mestre, C., & Prince, P. (1997). Second language autonomy. *Journal of Memory and Language*, *37*(4), 481–501.

Frings, C., Schneider, K. K., & Fox, E. (2015). The negative priming paradigm: An update and implications for selective attention. *Psychonomic Bulletin & Review*, *22*, 1577–1597.

Green, D. W. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition*, *1*(2), 67–81.

Grison, S., & Strayer, D. L. (2001). Negative priming and perceptual fluency: More than what meets the eye. *Perception and Psychophysics*, *63*, 1063–1071.

Henson, R. N., Eckstein, D., Waszak, F., Frings, C., & Horner, A. J. (2014). Stimulus-response bindings in priming. *Trends in Cognitive Sciences*, *18*, 376–384.

Houghton, G., & Tipper, S. P. (1994). A model of inhibitory mechanisms in selective attention. In D. Dagenbach & T. Carr (Eds.), *Inhibitory mechanisms in attention, memory and language* (pp. 53–112). San Diego: Academic Press.

Klecha, A. (2013). Language and task switching in Polish-English bilinguals. *Psychology of Language and Communication*, *17*(1), 17–36.

Kleinman, D., & Gollan, T. H. (2018). Inhibition accumulates over time at multiple processing levels in bilingual language control. *Cognition*, *173*, 115–132.

Kotey, P. A. (2007). *Hippocrene concise dictionary: Twi-English, English-Twi. Third printing*. New York: Hippocrene Books.

Kramer, A. F., & Strayer, D. L. (2001). Influence of stimulus repetition on negative priming. *Psychology and Aging*, *16*, 580–587.

Kroll, J. F., Bobb, S. C., Misra, M., & Guo, T. (2008). Language selection in bilingual speech: Evidence for inhibitory processes. *Acta Psychologica*, *128*(3), 416–430.

Levin, J. R., & Neumann, E. (1999). Testing for predicted patterns: When interest in the whole is greater than in some of its parts. *Psychological Methods*, *4*, 44–57.

Li, C., & Gollan, T. H. (2018). Cognates interfere with language selection but enhance monitoring in connected speech. *Memory & Cognition*, *46*(6), 923–939.

Li, L., Neumann, E., & Chen, Z. (2017). Identity and semantic negative priming in rapid serial visual presentation streams. *Attention, Perception & Psychophysics*, *79*, 1755–1776.

Lijewska, A., Ziegler, M., & Olko, S. (2016). L2 primes L1 – translation priming in LDT and semantic categorisation with unbalanced bilinguals. *International Journal of Bilingual Education and Bilingualism*, *21*(6), 1–16.

Linck, J. A., Schweiter, J. W., & Sunderman, G. (2012). Inhibitory control predicts language switching performance in trilingual speech production. *Bilingualism: Language and Cognition*, *15*(3), 651–662.

Macizo, P., Bajo, T., & Paolieri, D. (2012). Language switching and language competition. *Second Language Research*, *28*(2), 131–149.

Malley, G. B., & Strayer, D. L. (1995). Effect of stimulus repetition on positive and negative identity priming. *Perception & Psychophysics*, *57*(5), 657–667.

McLennen, K. S., Neumann, E., & Russell, P. N. (in press). Positive and negative priming differences between short- and long-term identity coding of word-specific attentional priorities. *Attention, Perception & Psychophysics*.

Meuter, F. I., & Allport, A. (1999). Bilingual language switching in naming: Asymmetrical costs of language selection. *Journal of Memory and Language*, *40*, 25–40.

Mishra, R. K., & Singh, N. (2016). The influence of second language proficiency on bilingual parallel language activation in Hindi-English bilinguals. *Journal of Cognitive Psychology*, *28*(4), 396–411.

Misra, M., Guo, T., Bobb, S. C., & Kroll, J. F. (2012). When bilinguals choose a single word to speak: Electrophysiological evidence for inhibition of the native language. *Journal of Memory and Language*, *67*(1), 224–237.

Moore, C. M. (1994). Negative priming depends on probe-trial conflict: Where has all the inhibition gone? *Perception & Psychophysics*, *56*, 133–147.

Neely, J. H. (1991). Semantic priming effects in visual word recognition: A selective review of current findings and theories. In D. Besner & G. Humphreys (Eds.), *Basic processes in reading: Visual word recognition* (pp. 264–336). Hillsdale, NJ: Erlbaum.

Neumann, E., Cherau, J. F., Hood, K. L., & Steinnagel, S. L. (1993). Does inhibition spread in a manner analogous to spreading activation? *Memory*, *1*, 81–105.

Neumann, E., & DeSchepper, B. G. (1991). Costs and benefits of target activation and distractor inhibition in selective attention. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *17*, 1136–1145.

Neumann, E., & DeSchepper, B. G. (1992). An inhibition-based fan effect: Evidence for an active suppression mechanism in selective attention. *Canadian Journal of Psychology/Revue Canadienne de Psychologie*, *46*, 1–40.

Neumann, E., & Levin, J. R. (2018). Can the use of seven key manipulations and predicted pattern testing bring more clarity to negative priming investigations? *The American Journal of Psychology*, *131*, 3–18.

Neumann, E., McCloskey, M. S., & Felio, A. C. (1999). Cross-language positive priming disappears, negative priming does not: Evidence for two sources of selective inhibition. *Memory & Cognition*, *27*, 1051–1063.

Neumann, E., Nkrumah, I. K., & Chen, Z. (2018). Excitatory and inhibitory priming by attended and ignored non-recycled words with monolinguals and bilinguals. *Memory*, 1–12. doi:10.1080/09658211.2018.1447132.

Nkrumah, I. K., & Neumann, E. (2018). Cross-language negative priming remains intact, while positive priming disappears: Evidence for two sources of selective inhibition. *Journal of Cognitive Psychology*, *3*, 1–12.

Pritchard, V. E., & Neumann, E. (2009). Avoiding the potential pitfalls of using negative priming tasks in developmental studies: Assessing inhibitory control in children, adolescents, and adults. *Developmental Psychology*, *45*, 272–283.

Pritchard, V. E., & Neumann, E. (2011). Classic Stroop negative priming effects for children and adults diverge with less-conflicting and nonconflicting conditions. *The American Journal of Psychology*, *124*, 405–419.

Psychology Software Tools, Inc. [E-Prime 2.0]. (2012). Retrieved from http://www.pstnet.com.

Pylyshyn, Z. W. (1984). *Computation and cognition: Toward a foundation for cognitive science*. Cambridge, MA: MIT Press.

Schmitz, T. W., Correia, M. M., Ferreira, C. S., Prescot, A. P., & Anderson, M. C. (2017). Hippocampal GABA enables inhibitory control over unwanted thoughts. *Nature Communications*, *8*(1), 1–12.

Schoonbaert, S., Duyck, W., Brysbaert, M., & Hartsuiker, R. J. (2009). Semantic and translation priming from a first language to a second and back: Making sense of the findings. *Memory & Cognition*, *37*, 569–586.

Strayer, D. L., & Grison, S. (1999). Negative identity priming is contingent on stimulus repetition. *Journal of Experimental Psychology: Human Perception and Performance*, *25*(1), 24–38.

Wang, X. (2015). Language control in bilingual language comprehension: Evidence from the maze task. *Frontiers in Psychology*, *6*, 1–12.

Wu, Y. J., & Thierry, G. (2017). Brain potentials predict language selection before speech onset in bilinguals. *Brain & Language*, *171*, 23–30.

Wyatt, N., & Machado, L. (2013). Evidence inhibition responds reactively to the salience of distracting information during focused attention. *PLoS One*, *8*(4), e62809.