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BILINGUALISM IN THE TEENAGE YEARS: LEXICAL JUGGLING IN BILINGUAL MEMORY AS EVIDENCED BY NEGATIVE AND POSITIVE PRIMING EFFECTS

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ABSTRACT: *The present experiments studied teenage bilinguals to advance the literature on the nature of bilingual lexical selection and representation using negative and positive priming manipulations. Our unilingual experiment showed positive priming effects in the attended repetition condition where the prime and probe target words were the same, whereas negative priming effects were found on trials where the prime distractor word matched the probe target. In the cross-language experiment, the ignored repetition negative priming effect subsisted across-languages, but cross-language attended repetition positive priming effect did not. We further tested the impact of second language proficiency on the cross-language manipulations but found no interaction between priming effects and second language proficiency. Our results corroborate the argument that the languages of the bilingual are stored and accessed together (Neumann et al., 1999), and that inhibitory control is the system that regulates bilingual language use. However, contrary to previous studies (eg., Nkrumah & Neumann, 2017) second language proficiency played no role in modulating the two automatic sources of inhibition*.

KEYWORDS: teenagers, negative priming, bilinguals, lexical decision task

INTRODUCTION

Research shows that the two languages of a bilingual are simultaneously activated (*otherwise called language non-selectivity*) if a bilingual reads (Dijkstra, 2005), hears (Marian & Spivey, 2003) or speaks (Kroll, Bobb & Wodniecka, 2006) one language alone (*see also* Blumenfeld & Marian, 2007; Gullifer, Kroll, & Dussias, 2013; Rossmark, van Hell, de Groot, & Starreveld, 2014). Far less is however known about how the two languages are stored and accessed in memory, and more importantly, the system that regulates the languages (or the words within them) following such simultaneous co-activation. These issues were examined in this study with a primed lexical decision task (LDT) wherein the importance of each of the bilingual's two languages evolved in consistent and rotating sequence between prime and probe targets thereby inducing attentional selectivity between the two languages. Two experiments were conducted in this study. First, a unilingual experiment in which all stimuli for the task were Twi words (Twi- an indigenous Ghanaian language). The unilingual experiment provided a baseline with which to compare a cross-language (Twi-English) experiment. It is worth noting that bilingualism characterises a spectrum rather than a categorical variable (Kroll & Bialystok, 2013; Luk & Bialystok, 2013; Kaushanskaya, 2015). Balanced bilingualism or equilingualism is a rare phenomenon, and language usage may vary throughout a person's lifetime. Hence, bilingualism herein was operationalised as the capacity to speak two languages and proficiency as one's fluency and frequency of use of a particular language.
The main objectives of the present study were to:

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(i) examine whether the languages of bilinguals are stored and accessed together or separately in memory
(ii) explore the system that regulates bilingual cross-language modulation
(iii) assess the role of second language proficiency in bilingual lexical selection and control

A unique characteristic of the present experiments was that the subjects were teenagers (see, Constantinidis & Luna, 2019). All the previous cross-language experiments cited so far used young adults and adult participants (Nkrumah & Neumann, 2017; Neumann, Nkrumah & Chen, 2018). However, behavioural manifestations of response inhibition suggest that adolescents are able to produce adult level responses on occasion, but lack the facility to engage systems mediating response inhibition in a consistent fashion. Thus, the system engaged in bilingual language use and control may behave differently between teenagers and adults, especially on tasks that demands attentional selectivity. Hence, the present study aimed to broaden our understanding of the system that governs language juggling and cross-language modulation from another perspective, that is, among teenage bilinguals.

Cross-language priming in a Lexical Decision Task

The LDT has been widely used in laboratory situations to study bilingual memory in cross-language priming experiments (Altarriba & Basnight-Brown, 2007). In LDT's subjects are asked to make timed manual decision (word or nonword judgement) to a thread of letters shown on the computer screen. Usually, subjects are quicker and more accurate on trials where the prime and probe target words are the same, similar or are related semantically, but are slower on trials where the nontarget prime item (or its similar or semantically related item) becomes the probe target.

It has been shown that (Collins & Loftus, 1975; Anderson, 1983) the momentary activation from a current encounter with a word facilitates its accessibility to subsequent words if the ensuing word is identical or semantically related, due to preactivation. If cross-language positive priming effect (where the translation equivalent of the prime distractor becomes the probe target) imitates those within languages (unilingual where the prime and probe target are the same or semantically related) then the two languages are assumed to be intimately interconnected in one language independent memory system. However, if positive priming effect fails to appear across languages, it implies that the languages are independent of each other, which is two independent language-specific memory systems (DeGroot & NAS, 1991; Keatley & Gelder, 1992).

Inhibitory control in bilingual lexical access and production

Most of the extant empirical studies in cognitive psychology have attempted to explain how the languages of a bilingual are stored and accessed in memory and the system that regulates the selection of the target language while preventing disruptions from the nontarget language during bilingual language use. Nkrumah and Neumann (2017) tested this debate in the context of unilingual and bilingual primed LDT. In their experiments, each trial display of prime-probe couplets contained target and nontarget words and their subjects were instructed to name the target word, while disregarding the simultaneously displayed distractor word. In the attended repetition condition, the prime and probe target items were the same, whereas in the ignored repetition condition, the conflicting prime nontarget word subsisted as the target probe item. In

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comparison to the control condition, their unilingual experiment (Nkrumah & Neumann, Experiment 1) showed a faster reaction time in the attended repetition condition, but delayed reaction time in the ignored repetition condition, indicative of positive and negative priming effects respectively. The cross-language version of their task (Nkrumah & Neumann, Experiment 2), asked subjects to name the prime target Twi item, and afterward make lexical decision to the probe target English item. For instance, naming '*atwedeɛ'* in the prime display and making a lexical decision to *ladder* (the English translation of '*atwedeɛ'*) in the attended repetition condition. Quite enthralling, their cross-language task produced no attended repetition facilitation effect, but ignored repetition negative priming was observed.

In a related experiment, Neumann, McCloskey and Felio (1999) required English-Spanish bilinguals to name prime target English words followed by making lexical decisions as to whether a string of letters composed legal words in Spanish or not. Although their ignored repetition condition produced significant negative priming effects, attended repetition facilitation effect were not reported (Neumann et al., Experiment 2). Regarding the cross-language results in both studies, the researchers (Neumann et al., 1999; Nkrumah & Neumann, 2017) conjectured that bilinguals are able to isolate their languages such that once response to a prime target is done in one language, the second language takes precedence, and this is achieved in part through a generalised en masse suppression of the prime target language. Further, the inhibition applied to the prime distractor (in the ignored repetition condition) spreads to its translation equivalent (the probe target). Thus, the cumulative impact of such parallel inhibitory processes results in weakening positive priming effect in the attended repetition condition, while concurrently strengthening negative priming effect in the ignored repetition condition.

According to Levelt (1989) the fundamental process of speaking is word selection wherein all other linguistic processes function. Word selection or lexical access (*otherwise described as speech production*) occurs under competition. To summarize, when a concept specified in the conceptual system activates a word in the mental lexicon, the activation spreads through the lexico-semantic network, and other neighbouring words are equally activated. Thus, selection is a competitive process (Ferreira, 2010). In bilingual lexical selection, lexical rivalry from semantically similar and identical words in the nontarget language is impaired. However, bilinguals primarily activate their two languages when given a linguistic task (Costa, 2005; Kroll, Bobb & Wodniecka, 2006). Accordingly, the initial conflict between target and nontarget languages is assumed to be resolved by a system of active inhibition (Inhibitory Control Model, Green, 1998). For instance, if a Maori-French bilingual is asked to name the picture of '*chaise'* in French, the rival translation corresponding word *'karau'* in the nontarget Maori language is inhibited to permit the selection and pronunciation of the French target *'chaise'*. Choosing one language against the other demands selective modulation. The present study initially explored exogenous selection of an attended word between other competing nontarget word in a unilingual study (Experiment 1) and further investigated such bilingual language modulation in a cross-language manipulation (Experiment 2) using the LDT.

Inhibition based account of priming

The inhibition-based model suggests that when a situation demands attentional selectivity, an inhibitory control mechanism acts on the formerly attended information that is no more

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required (Neumann & DeSchepper, 1992) but is likely to become interfering. The inhibitory mechanism is like the distractor inhibition that seemingly produces negative priming effects, but it is an endogenous form of such inhibition. Endogenous inhibition acts on internally represented stimuli that has the possibility to impede responses to targeted stimuli, while exogenous inhibition suppress nontargets that are evident in the environment. Experimental indices of both forms of inhibition are manifested in the suppression of disrupting irrelevant stimuli and should therefore have effects for the following accessibility of associated stimuli (Neumann & DeSchepper, 1992; Neumann, Cherau, Hood & Steinnagel, 1993). For example, in order to understand how English-Spanish bilinguals select the meaning of words that possess different meanings but share similar orthography across languages (*interlexical homographs such as head, meaning cabeza in Spanish*), Macizo, Bajo and Martin (2010) asked their subjects to make decisions as to whether pairs of English words were related or not. The researchers observed delayed responses to homographs displayed together with words that shared related meanings with the Spanish homographs, compared to the control items. Quite fascinating, subjects showed delayed responses when the English translation of the Spanish homograph word was displayed in the next pair of English words. Macizo et al. surmised that the subjects inhibited or suppressed the unattended, nontarget homograph meaning so that they could respond to the target task and thus, bilinguals employ inhibitory control processes (to select a language) when they face comprehension tasks. In the current cross-language manipulations, it is assumed that endogenous inhibition is engaged to suppress the language of the prime stimuli (after naming the prime target Twi word) in order to prevent any possible interference with the probe target language (English language). This might lead to a reduction or complete loss of cross-language positive priming. Nevertheless, the inhibition of the nontarget prime item must elicit negative priming if the next probe target is a translation equivalent of the ignored prime. Thus, since there is a global suppression of the prime language and a local inhibition of the ignored prime item, negative priming is expected to remain intact, but positive priming might not (see Neumann et al., 1999).

Experiment 1

Experiment 1 tested negative and positive priming effects within language. Experiment 1 was a conceptual replication of past studies (e.g., Neumann & Nkrumah, 2017). It was particularly conducted to serve as a baseline for contrasting the outcome of Experiment 2.

METHODS

Subjects

Seventy-six (43 male and 33 female) students from junior high schools in the Cape Coast municipality of Ghana participated in Experiment 1. The subjects were around the ages of 11 to 13years. All the subjects reported normal or corrected to normal vision. The present experiment met the approval of the Ethics Committee of the Ghana Education Service, regarding experimental studies with human subjects.

Stimuli and Apparatus

The word stimuli (620 words) employed in the study were selected from the word norms of Frances and Kucera and their frequency of use ranged between 32 to 50 uses per million. All the English words were replaced by their Twi translation equivalents with the help of the Twi-

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English-English-Twi Hippocrene Concise Dictionary (Kotey, 2007). One hundred and sixty-eight words acted as targets and the others were used as filler words. Ninety-six Twi pronounceable nonwords were also formed (e.g., '*kurewa'*- instead of '*kuruwa'*). The nonwords were carefully scrutinized to confirm that they did not compose valid words in another language. In order to curb any predictive association between word and nonword groupings, the letter strings for both groups were kept similar. All the trial sets (word, and nonword) were organised in a random fashion and the same order was preserved for all the subjects indiscriminate of counterbalancing group and condition. For example, if the probe target word '*aduro*' was shown on the 25th trial for Group A in the attended repetition condition, it also appeared on the 25th trial for Group B and also on the 25th trial for Group C.

In order to elicit pure priming effects, only 6.7% attended repetition trials were maintained in the task because subjects are fast to develop expectancies and boost their performance as related proportion becomes more (Neely, 1991; Neely, O'Connor & Calabrese, 2010). Equivalent numbers of word and nonword trials were also kept because if the number of word trials exceeded those of nonword trials, subjects may incorrectly offer a word response when a nonword appears (Altarriba & Basnight-Brown, 2007). All the word stimuli appeared once in a prime-probe trial set except to satisfy attended repetition or ignored repetition trials, in which case they were shown maximally twice. Subjects used 24 practice trials to familiarise themselves with the requirements of the task. None of the practice words reappeared in the main task. Word width took approximately 1.4cm (1.6 degrees of visual angle) and 5cm (5.7 degrees of visual angle) of the computer screen for the shortest and longest words respectively. Letters were written in black print, calibri font size 11, and targets were kept in lowercase letters and distractors in uppercase letters. Target and distractor items were displayed one on top of the other with minimal separation (about 1pixel width), and their positions were such that 50 percent of the targets appeared on top and 50 percent at the bottom, across all conditions. This presentation style was aimed at reducing subject's ability to predict in advance, the position of the target. Prime items were shown either in the middle, or slightly close to the left or right of the centre and each location was utilised 1/3 of the period for each condition, because varying stimulus position increases the strength of negative priming better than when fixed stimulus locations are preserved (Langley, Overmier, Knopman & Prod'Homme, 1998). Probe stimuli were always shown at the centre of the screen. A Hewlett-Packard (HP, 15.6inch) laptop computer was used in conducting the experiment. All programming was done with E-Prime 2.0 software programme (Psychology Software Tools, Inc.). A 5-button PST Chronos response box was engaged in registering lexical decision reaction times (Psychology Software Tools, Inc., 2012) and a tape recorder was used to record subjects' naming of the prime targets (prime targets were later checked for correct and incorrect responses on a pre-generated response sheet).

Design

Experiment 1 employed a within-subject design. The independent variables of Attended Repetition (AR), Control (Co) and Ignored Repetition (IR) conditions were manipulated in order to ascertain subjects' response time and accuracy scores on reacting to the probe target stimuli. The nonword trials were not analysed.

Procedure

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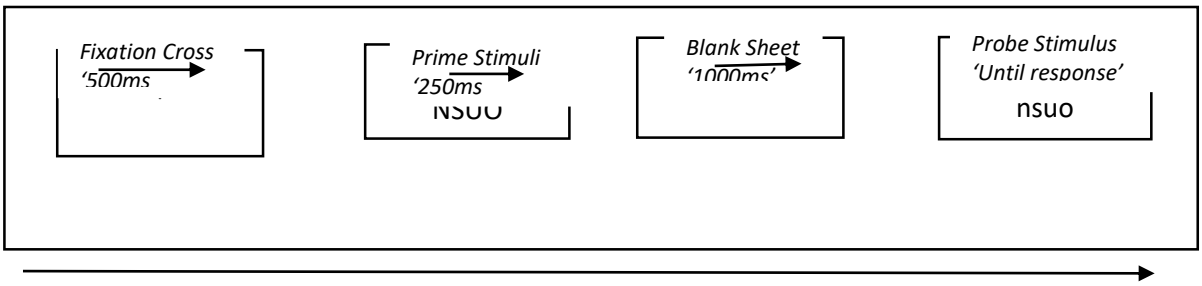
Subjects individually completed the experiments in a quiet and dimly lit room, at a position of about 50cm from the computer screen. Due to comparative newness with technical apparatus, the researcher painstakingly explained the task to the subjects. Before a subject started the main task, they had to repeatedly rehearse the (24) practice trials successfully. The experimenter stayed outside the experimental room to avoid distractions as soon as the main experiment started. The main experiment consisted of 144 prime-probe trial couplets of 72-word (divided equally among the attended repetition, control and ignored repetition conditions) and 72 nonword trials and subjects took about one hour and thirty minutes to finish the task.

The experimental order was first, a fixation cross displayed in the middle of the computer screen for 500ms. This was followed by the prime trial which was shown for 250ms, and when the prime display had disappeared, a blank screen emerged for 1000ms whilst the subject named the prime target. Next was the probe which was shown on the screen and remained until the subject made a lexical decision. The relevance of both speed and correctness were reiterated and subjects were advised to react to trials as fast as they could, yet being cautious not to commit errors. They were asked to disregard the nontarget items in order to enhance their speed and accuracy in processing the targets. Subjects registered their lexical decisions by pressing the designated "word" and 'nonword' buttons on the response box. Once a decision was made, the following trial sequence was initiated. This order persisted throughout the task. Figure 1 is an illustration of the trial-couplet arrangement.

Fig 1: Sample of Prime-Probe Couplets in the Ignored Repetition Condition



RESULTS AND DISCUSSION

Analysis

A cut-off score of 30% or above for naming (word/nonword) and decision errors was adopted. Any data that contained such number of errors did not receive further analysis. All the 76 subjects qualified for further analysis. Compared to the Control (Co) condition, the attended repetition (AR) condition showed faster reaction times, while the ignored repetition (IR) condition showed slower reaction times suggestive of positive and negative priming effects respectively. The results are presented in Figure 2. These effects were supported by an analysis of variance *[ANOVA; F (2,150) = 17.18, MSE =158319.11, p < .001, n^2p = .19]*. Owing to the specificity of the hypotheses raised, paired samples t-test were conducted in addition to find out whether significant facilitation and delay effects were produced by the AR and IR conditions respectively, relative to the Co condition. As predicted, the AR condition *(M= 2723.55, SD = 303.27) showed* significantly lower reaction time than the Co condition *(M= 2769.07, SD= 303.59), t (75) = 3.09, p=.003, d=.02* and the IR condition *(M= 2814.83, SD =*

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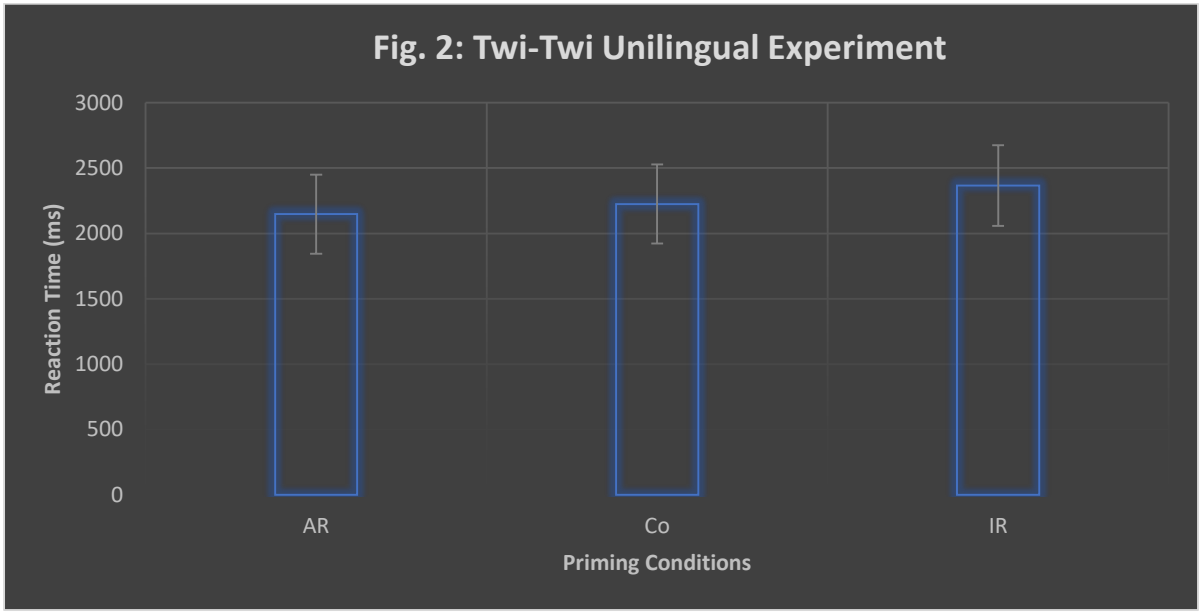
308.07) showed a significantly delayed reaction time compared to the Co condition *(M= 2769.07, SD=303.59), t (75)=2.91, p=.005, d= .15.*

Error rates were analysed in a similar way. The main effect of priming was significant *[ANOVA; F (2,150) = 4.63, MSE = 6.37, p=.01, n^2p = .06]*. However, neither the contrast between *AR (M= 22.17, SD = .89) and Co (M= 21.89, SD = 1.10), t (75) =1.78, p=.08, d=.28 nor IR (M= 21.59, SD = 1.44) and Co (M= 21.89, SD = 1.10), t (75) = 1.43, p=.16, d=.24 was significant.*



Discussion

Experiment 1 elicited significant positive priming in the attended repetition condition and negative priming in the ignored repetition condition. The negative priming effect observed in this experiment supports findings by Neumann and colleagues (e.g., Neumann et al., 1999; Nkruma & Neumann, 2017) that negative priming does not depend on repeated stimuli presentation. One interpretation of these results is that ignored distractor prime words that are displayed only once preceding a probe target can elicit robust negative priming effect.

Experiment 2

Experiment 2 explored how the modulation of words and languages in the current selective attention manipulations could explain the nature of the system that underpin bilingual language organisation and processing. Experiment 2 was a cross-language version of Experiment 1. All the prime stimuli as well as the probe nontarget stimuli were in the first language of the bilinguals (Twi), and the probe target words were in second language (English). The independent (but interconnected) model suggests that languages are contained in different modules (eg., Scarborough, Gerard, & Cortese, 1984; Durlik, Szewczyk, Muszynski & Wodniecka, 2016), and therefore expects little or no priming effect of any kind across languages since the associations between distinct language-specific memory systems (or modules) are weaker compared to within language systems. Separate-store models thus expect

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a complete absence or significantly reduced positive priming facilitation effect between languages, relative to within language positive priming. However, the single store model (e.g.,Altarriba, 1992; Paradis, 1997) believes that the impact of a prime target on a probe target happens in a common propositional semantic network, and thus predict attended repetition facilitatory priming across languages (e.g., *tɛkrɛma ~ tongue*). For example, Neumann et. al, (1999) reported a negative priming effect in the absence of positive priming in a cross-language task and indicated that their results: (1) supported the single store model of bilingual language organisation, (2) opposed the episodic retrieval suppositions and (3) provided evidence in support of the inhibition-based account.

The inhibition-based model has shown that effective inhibitory control facilitates a bilingual's ability to settle cross-language conflict in word comprehension (Misra, Guo, Bokk & Krol, 2012; Mercier, Pivneva, & Titone, 2014). The hypothesis underpinning how such control is achieved is that language selection demands initial excitation and subsequent inhibition mechanism that is able to act locally on discrete nontarget lexical items and globally to activate and consequently inhibit entire languages (Neumann et al., 1999; De Groot & Christoffels, 2006; Nkrumah & Neumann, 2017). Given this premise, the study predicted ignored repetition negative priming in the present cross-language manipulations but no attended repetition positive priming effects, and such hypothesis also support the assumption that languages are integrated in a single store system (see Neumann et al., 1999; Nkrumah & Neumann, 2017).

Method

Subjects

Eighty-six subjects (49 males and 37 females) from junior high schools in the Bekwai Municipality in the Ashanti Region of Ghana, voluntarily took part in this experiment. Their ages ranged from 13 to 16 years with a mean age of 13.9years. They all reported normal colour vision. *None of the subjects used in Experiment 2 was a participant in Experiment 1.*

Stimuli and Apparatus

The stimuli were those employed in Experiment 1, but the Twi probe target words were substituted by their noncognate English translation words. (see Appendix A). The 72 probe target words and 184 filler words were identical to those employed in Experiment 1. The prime stimuli were Twi items and were made up of a lowercase target word and uppercase distractor word one on top of the other similar to Experiment 1. The probe items were also made up of uppercase distractors in Twi and lowercase targets in English (or a set of letters that formed pronounceable nonword in English, e.g., *tawel* instead of *towel*). A language history questionnaire (adopted from Nkrumah & Neumann, 2017) was given to the teachers to report on the subjects' English proficiency background (*the teachers were class teachers of the students and they were assumed to provide better accounts of the subjects' proficiency since they interacted with them on daily school basis*). The experiment was controlled by E-Prime and HP laptop. All other materials were the same as those used in Experiment 1.

Design and Procedure

The attended repetition, control and ignored repetition conditions employed in Experiment 1 were again used in Experiment 2 and the methods employed were similar as done in

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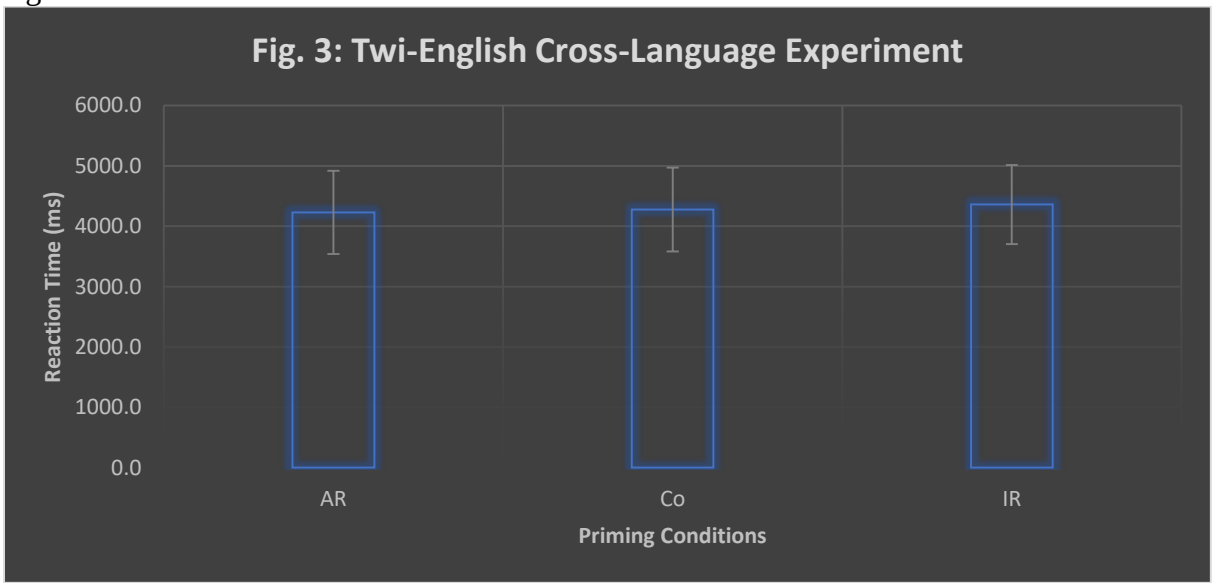
Experiment 1. In summary, subjects sat about 50cm from the computer screen and they were asked to name the target (Twi) item in the prime (appearing either centrally or slightly towards the right or the left of the centre) as quickly and as correctly as possible. They were also told about the second display (the probe) which emerged at the centre of the screen and they had to make word/nonword judgements as to whether the lowercase item was a real English word or not. As in Experiment 1, speed and accuracy were highlighted, and the merits of disregarding the distractors were emphasised. Subjects reacted to 24 practice trials and 144 experiment-proper trials and the order of procedures in the experiment was similar as those used in Experiment 1.

Results and Discussion

The cut-off score established in Experiment 1 was maintained for Experiment 2. Any data set that contained 30% or over for naming and reaction errors were removed from further analysis. Based on the cut-off score adopted, 10 subjects were removed from subsequent analysis. As compared with the Co condition, the AR condition showed no facilitation effect, but the ignored repetition condition showed robust delay. These effects were supported by an analysis of variance *[ANOVA; F (2,146) = 12.53, MSE =317383.65, p < .001, n^2p = .15]*. Planned comparison using t-test for correlated means showed that the contrast between *AR (M= 4230.12; SD= 690.61) versus CO (M= 4276.49, SD= 693.73), t (73) = 1.91, p=.06, d=.07* did not approach statistical significance. However, the contrast between *IR (M = 4359.39; SD = 654.04) and CO (M = 4276.49; SD = 693.73), t (73) = 3.32, p =.001, d=.12 was significant.*
Error analyses were done in a similar way. The main effect of priming was not significant *[ANOVA, F (2,146) = 3.04, MSE=3.79, p=.05, n^2p=.04]*. Neither the contrast between *AR (M=21.95, SD=.95)* and *CO (M= 21.95, SD= 1.13*), *t (73) =.00, p=1.0, d=.28* nor *IR (M=21.55, SD=1.37),* and *CO (M= 21.95; SD= 1.13), t (73) =2.02, p=.05, d=.24* was significant.



Reaction times were further analysed by grouping the data into: (1) less proficient and (2) more proficient bilinguals based on the subject's scores on the Language Proficiency Questionnaire (adopted from Nkrumah & Neumann, 2017, see Appendix B). It must be noted that the questionnaires were completed by the high school teachers (*the class teachers had stayed in*

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the school for over ten years and had known and frequently interacted with the students understudy for at least one year so they could report better on the students language competencies). The researcher aggregated the scores on each subject's questionnaire and created a median split for the groups. The median score for the subjects was 73 and a median split based on this described 30 subjects as less proficient and 44 as more proficient.

The language proficiency analysis showed a main effect of priming *[ANOVA, F (2,144) = 12.99, MSE= 327742.55, p<.001, n^2p= .15],* but no interaction effect between priming and proficiency *[ANOVA, F (2,144) = 1.23, MSE=32435.91, p=.28, n^2p=.02]. This suggested to us that language proficiency had no influence on priming effects so the analyses were terminated at this stage.*

Error analysis were done in similar way. There was no main effect of priming *[F (2, 144) = 2.72, MSE= 3.43, p= .07, n^2p= .04]* nor interaction effect between priming and proficiency *[F (2, 144) = .09, MSE= .11, p=.92, n^2p=.001]*.

Discussion
Experiment 2 produced enthralling findings that warrant theoretical and empirical elucidations: (1) the results showed significant ignored repetition negative priming effects but no attended repetition positive priming effects (2) there was no interaction between language proficiency and priming effects.

SUMMARY OF RESEARCH FINDINGS

The current manipulations provide a comprehensive account of bilingual language processing and the role of second language proficiency in bilingual language control, among teenagers. First, the results suggest that negative priming effects can occur with novel stimuli presentation as shown in the unilingual results in Experiment 1, and corroborated by the cross-language experiment (Experiment 2). Despite no attended repetition facilitation effect in Experiment 2, robust ignored repetition negative priming was recorded. Second, the results illuminate our understanding of the system engaged in bilingual lexical access and control. Thus, an inhibitory control mechanism is at play to control influences of one language when the other is in use. Finally, contrary to earlier results reported on the function of second language proficiency in modulating the two automatic sources of selective inhibition (Neumann et al., 1999), the present results found no interaction between language proficiency and priming effects.

General Discussion

Bilingual Language Use and the role of Inhibitory Control Processes
In the present experiments, prime and probe target languages were presented in regular alternation and in systematic and predictable sequence. Hence it is assumed that subjects could inhibit the entire prime language (Twi) after the prime target naming. Thus, subsequent to the naming the prime target (Twi word), the whole Twi language becomes somewhat extraneous and possibly interfering, since subjects were aware that the next (probe) task is in English. And so, maintaining the Twi language system activated might negatively affect the next lexical decision to the English probe target. Subsequently, the Twi (prime) language is inhibited to

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prevent it from posing distractions to the English language (the probe target language), and this prevents it from spreading to its translation equivalent probe target (English) word. A local type of inhibition however acts particularly on the prime (Twi) distractor word, during naming of the prime target. The 'selective' inhibition applied to the prime target however extends to its English translation equivalent word and subsequently impairs processing of that word if it appears as the probe target item. The collective impact of global inhibition of the nontarget language coupled with the local inhibition of the prime distractor item perhaps increased the negative priming effect observed in the ignored repetition condition, but consequently impaired any potential facilitation effect between the prime target and its translation counterpart in the probe (*see* Nkrumah & Neumann, 2017).

The simultaneous activation of the prime target and distractor words and the ensuing inhibition of the prime distractor word when naming the target corroborates the hypothesis that inhibition enforced on the mental representation of the nontarget prime (Twi) word when choosing the target potentially extends to its semantic neighbours, such as its conceptual translation counterpart in the English language, and so if that concept appears as target word in the probe, processing of that word is delayed. Put another way, the prime distractor word is initially processed concurrently with the prime target, however the prime target is selected against the prime distractor. This involves, in part, the suppression of the mental representation of the 'likely' distracting prime nontarget item in order to block any form of interference. The inhibition however advances to its semantic neighbours including its conceptual English equivalent, and thereby weakens subsequent processing of that concept (the English equivalent), if it happens to be the following word that demands lexical decision response. Such elucidations suggest that lexical representations of words which are strongly related, herein translation equivalents, have some direct links, indiscriminate of language. Furthermore, since the negative priming effect was elicited in the ignored repetition condition (ignored word), instead of the attended repetition condition (attended word), post lexical meaning integration and other strategic processes can be conveniently withheld.

5.2 The Teenager's Memory: Second language proficiency and its impact on lexical production

Constantinidis and Luna (2019) have shown that inhibitory control matures through adolescence and into early adulthood, and impacts on decision-making, and that impairments in inhibitory control are associated with various psychopathologies, many of which emerge during adolescence. Thus, it is possible that unlike adult bilinguals, the mechanism of language juggling in response to target and nontarget languages and lexical items are handled differently by adolescents. Again, behavioural manifestations of response inhibition suggest that adolescents are capable of producing adult level responses on occasion, but lack the ability to engage systems mediating response inhibition in a consistent fashion. Since the present lexical decision task required consistent alternation of languages between prime and probe targets, adolescents were expected to handle inhibitory demands different from how adults may probably do it. In spite of such diverse cognitive characteristics outlined by Constantinidis and Luna (2019), the results found in the unilingual experiments were similar to those obtained by Neumann and colleagues who used adult populations.

However, unlike the proficiency effects expressed in the other studies (Neumann et al., 1999; Nkrumah & Neumann, 2017) the present cross-language manipulations showed that second

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language proficiency has no impact on bilingual language control. In the studies reported by Neumann et al (1999) and Nkrumah and Neumann (2017), adult populations were used. Herein, the difference in population (maturational differences) appear to be playing a role. Because Neumann and his colleagues suggested that more proficient bilinguals can completely switch off (Macnamara & Kushnir, 1971; Heredia & Altarriba, 2001; Bobb & Wodniecka, 2013; Beatty-Martinez, Navarro-Torres, & Dussias, 2020) their first language (Twi) when the next lexical decision reaction demand another language (English). Thus, after using Twi for the prime naming task, a global inhibition of the Twi language conveniently ensues, giving preference to the upcoming target language (English) and that led to the absence of positive priming but robust negative priming effects in those studies. To Neumann and colleagues, less proficient bilinguals use the first language as a form of crutch in accessing the second language and so they cannot engage in switching off the first language even when it is not required. The present study provides a counter explanation by showing that teenage bilinguals use languages in the same way whether they are more or less proficient in the second language. For instance, Sprondel, Kerstein and Kipp (2012) have shown that improvement in source memory performance throughout development is largely mediated by strategic processes that facilitate the retrieval of task-relevant information. And that memory accuracy improves with age and also increase with decreasing control demands in age groups. They submit that adults implement a strategy to prioritize recollection of target information with greater success, different from adolescents, regardless of control demands and that reflects maturational differences in cognitive control. In support of this view, there is assumed to be a strategic process (perhaps inhibition) used by adult and teenage bilinguals but teenage bilinguals use it the same way irrespective of their proficiency status, whereas in the case of adults, proficient bilinguals use it differently from less proficient ones. Thus, the present study suggests protracted maturation in the strategic processes that underpin selective inhibition and post-retrieval control.

Implications for the Inhibition Based Model of Priming

The absence of attended repetition positive priming effects but enhanced ignored repetition negative priming as revealed in the cross-language experiment challenges the hypothesis that the non-appearance of positive priming effects across languages support the separate-store model, but rather substantiates the alternate assumption that employing positive priming indices alone to explain bilingual language structure could impair the theoretical advancement in bilingual memory studies. Again, the hypothesis that selective inhibitory control can act on individual words and also more globally on a language (Green, 1998; Kroll Bobb, Misra & Guo, 2008; Misra et al., 2012; Nkrumah & Neumann, 2017) explains why there could be negative priming without positive priming effects in a cross-language task. First, there is a global kind of inhibition acting on the prime language (Twi) after the prime target naming is complete (to prevent that language from interrupting the next task in the English language). In addition to this global inhibition, a local inhibition also acts selectively on the prime distractor word to prevent it from intruding the activities of the prime target. The inhibition applied to the prime distractor automatically spreads to its translation equivalent and impairs response to that word (the translation equivalent) when it becomes the next probe target requiring lexical decision. Cumulatively, these explanations demonstrate the plasticity of inhibitory effects by showing that inhibition can be directed to diverse characteristics of the stimuli depending on the demands of the task (Tipper & Weaver, 1994) and this does not involve conscious

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strategies. By inference, subjects are unconscious that they have employed inhibitory processes to suppress or inhibit any distracting nontarget information. Rather, the suppression that the distracting nontarget item experiences is an automatic by-product of responding to what is very salient at the time (Neumann & DeSchepper, 1991, 1992). Such inhibition occurs when high conflicting stimuli compete for selection. The current manipulations widen our understanding that both mechanisms of local and global inhibition emerging within the same task provide support to suppressive mechanisms and thus inhibition may be more pervasive than previously realised (see Li et al, 2017).

CONCLUSION

The present findings settle with the methodological assumption that negative priming effects can be obtained with large groups of nonrecycled words that are presented once in an experiment or maximally twice to fulfil attended repetition and ignored repetition conditions (Neumann et al. 1999; Nkrumah & Neumann, 2017). The findings also corroborate earlier studies by showing that inhibition (emerging from the local and global suppression of individual items and global languages respectively) plays a passionate role in bilingual lexicalisation processes. However, the study shows that although language proficiency plays a role in bilingual lexical access and production among adult populations (e.g., Nkrumah & Neumann, 2017), language proficiency did not play any role in lexical access in the case of teenage bilinguals.

Final Thoughts

Our results are in line with those of Duyck et al.(2004), which showed equal cross-lingual phonological priming effects between balanced and less proficient Dutch – French bilinguals. The results further demonstrate that the activation of visually presented words may be equally strong in both more and less proficient teenage bilinguals. However, the present study cannot completely rule out such an explanation that our participants' second language proficiency does not differ so much and causes insignificant cross-language priming effect. Although we found significant differences in proficiency between the less and more proficient participant groups, the subjects were all still relatively experienced with English (the second language). If the study is expanded to include more novice teenagers, there could be a significant effect of proficiency in the cross-language priming effects.

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Appendix A

Twi (English) Prime Target/Distractor Words

asobrakyeɛ (deaf)	aseresɛm (comedy)	awareɛ (marriage)	odwan (sheep)
ɛwoɔ (honey)	ɔbaa (female)	bɔsuo (dew)	mfomsoɔ (error)
toa (bottle)	mukaase (kitchen)	nokware (truth)	akoa (slave)
kanea (lamp)	amanaman (gentile)	nnaadaa (deception)	obubuani (lame)
efunu (corpse)	abɔfra (baby)	nhwɛsoɔ (example)	atere (spoon)
mpataa (fish)	ɔmanba (citizen)	asotwe (punishment)	ahenasa (triplet)
hyire (powder)	ɔdɔ (love)	afiase (prison)	kuruwa (cup)
atwedeɛ (ladder)	esum (gloom)	kɛtɛasehyɛ (bribe)	kwata (leprosy)
asoɔkye (waves)	edwam (market)	ahaban (leaf)	simma (second)
ayaresabea (hospital)	ɔhyɛ (compulsory)	oguamma (lamb)	akokoduru (bravery)
daakye (future)	sradeɛ (butter)	paneɛ (needle)	kwaeɛ (forest)
ayɛyie (praise)	aberebeɛ (zebra)	okunafoɔ (widow)	ɛka (debt)

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Filler Words

aponkyerɛni (frog) ɔbɔfoɔ (hunter)	Agyapade (inheritance)	Aduhwam (perfume)	samanwa (tuberculosis)
nisuo (tears)	ɛtwene (bridge)	akwatia (short)	aduane (food)
ahemakye (dawn)	ɛfa (half)	bɔhyɛ (promise) abɔnten (street)	ɔtwerɛfoɔ (writer)
agyenkwa (saviour) anoteɛ (fluency)	ɔkraman (dog)	animguaseɛ (disgrace)	asubɔ (baptism)
anomaa (bird)	adaeso (dream)	adanko (rabbit)	nsaden (alcohol)
ntomtom (mosquito)	sofi (shovel)	nhyira (blessing)	ankora (barrel)
aprapransa (porridge)	anɔpa (morning)	ankaadwea (lemon)	nufoɔ (breast)
tenten (length)	ɔhwɛ (care)	afidie (trap)	nsoroma (star)
twɛdeɛ (blow) nwononwono (bitter)	mpoano (beach)	gyitae (guitar)	ɔtomfoɔ (blacksmith)
mogya (blood)	ɔgyeɛ (deliverance)	ɛnam (meat)	mmabunu (youth) sikakorabea (bank) asensene (tetanus)
baanu (pair)	ɔwansene (antelope)	ɔtadeɛ (lake)	etuo (gun)
sereɛ (laughter)	ahomasoɔ (pride)	ntaafoɔ (twins)	mmoa (assistance)
maame (mother)	bosome (month) biribiwa (trifle)	adiyi (manifest) nwoma (book)	wowa (bee)
funuma (navel)	abisadeɛ (request)	mmara (law)	nsrahwɛ (tour)
kyɛwpa (apology) ɔhemmaa (queen)	agokansie (sports)	sukuupɔn (university)	adansefoɔ (witnesses) kooko (piles)
akodeɛ (weapon)	sapɔ (sponge) ahunahuna (threat) ɔkwantuni (traveller)	nhyiamu (meeting) nkyene (salt)	ahina (pot)
owuo (death)	asɛnnibea (court)	ɔsoro (heaven)	nkɔmhyɛ (prophecy)
ahoɔtan (ugly)	kokurobetie (thumb) ɛbere (season)	bɔneka (confession) akuma (axe)	bokiti (bucket)
apɛde (wish)	nantwie (cow) adefoforo (new)	ɔheneba (princess) ataadeɛ (dress)	yoma (camel)
mmɔre (dough)	aboɔden (dear)	adwumayɛni (worker)	ɔsraani (soldier)
asuten (river)	pii (plenty)	amannɔne (abroad)	anifura (blind)
ɔberɛfo (destitute)	nkasɛɛ (bone)	ahenkyɛw (crown)	nimdeɛ (knowledge) nneyɛe (manner) yaredɔm (plague)
ɛnne (voice)	ntoma (garment)	afuro (stomach)	sikasɛm (finance)
ahoɔhare (brisk)	egya (fire)	akwamma (vacation)	ntasuo (saliva)
ntwitwieɛ (bruise) asikyire (sugar)	akyɛdeɛ (donation) asubura (spring)	kwadu (banana) ɔsaman (ghost)	nnawɔtwe (week)
akwaaba (welcome) homeda (sabbath)	ehu (fear)	sukɔm (thirst)	kosua (egg)
akorasɛm (rivalry) okuani (farmer) sakraman (fox)	wɔfa (uncle)	agradaa (thunder)	kronkron (holy)
akurase (village)	takra (feather)	bepɔ (mountain) ɔpɛpɔn (january) abadwafoɔ (audience)	ɔdwontofoɔ (musician) ɛhwene (nose)
abɔsrɛmka (myth)	bosea (loan) ɔtɛmmuafoɔ (judge)	abotan (rock)	ahweneɛ (beads)
ɔhyew (heat)	ɔsomafo (messenger)	etifi (north)	ako (parrot)
kotodwe (knee)	ninkunu (jealousy) apɔnkye (goat)	sika (money) mmebusɛm (proverb)	ayie (funeral)
osugyani (bachelor)	anigyeɛ (happy)	nananom (ancestors)	ɔsram (moon)
nkrataa (papers)	gyabidie (charcoal)	mfasoɔ (profit)	ahotew (purity) akyiwadeɛ (taboo)
ɛban (wall)	adakamoa (grave) sukuu (school)	atokoɔ (wheat)	ntutummɛ (locust) dadwene (problem) ahonyade (wealth)
abaa (stick)	ahonya (affluence)	gyidie (faith)	ahuro (foam)
atemu (judgement)	adetɔnni (trader)	akokɔsradeɛ (yellow)	ɛdɔn (clock)
nhwehwɛmu(research)	asau (net)	frankaa (flag) asasemfoni (map) wiem (sky)	ɛborɔ (poison) mmɔborohunu (merciful)
awɔ (cold)	anadwo (night) efiewura (landlord)		amanyɔsɛm (politics)
tɛkrɛma (tongue)			
mpaebɔ (prayer)			

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APPENDIX B- LANGUAGE PROFICIENCY QUESTIONNAIRE

Student ID:

Direction: Please, consider each rating within the context of what is appropriate for the academic status of each student. When completing this form, please think about the student's performance in the past six months

	Speaking	**Never**	**Sometimes**	**Often**	**Very often**
1	Initiate communication in English				
2	Observe grammatical rules when speaking				
3	Does not seem to make great pause and gaps in speaking				
4	Articulate words clearly				
5	Speak with ease				
6	Gives appropriate responses in a conversation				
	Comprehension	**Very well**	**Good**	**Some part of a problem**	**Problematic**
7	Can analyse and draw inferences from events narrated in English				
8	Can answer questions relating to a passage				
9	Can summarize a passage meaningfully				
10	Can use the English language to ask relevant questions in the course of a lesson				
11	Can follow direction communicated in English language				
	Reading	**Never**	**Occasionally**	**Often**	**Very often**
12	Pronounce words correctly				
13	Places vocal emphasizes on appropriate words				
14	Can pronounce unusual spellings, eg. Knew				
15	Observe punctuations and suitable courses				
16	Read primary in larger, meaningful phrase groups				
	Writing	**Never**	**Occasionally**	**Often**	**Very often**
17	Organize ideas meaningfully				

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18	Pay attention to correct spellings				
19	Use punctuations marks suitably				
20	Appropriate use of verbs, pronouns				
21	Write complete sentences				
	In comparism to other students, how would you rate the student overall performance in:	**Very good**	**Good**	**Average**	**Very average**
22	Reading				
23	Writing				
24	Speaking				
25	Comprehension				

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