Interlocutor identity guides language selection - An eye tracking study using blank screen paradigm

Thesis submitted in partial fulfillment
of the requirements for the degree of

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in
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by

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CERTIFICATE

This is to certify that the thesis entitled "**Interlocutor identity guides language selection - An eye tracking study using blank screen paradigm**" submitted by Amit Singh bearing Reg. No 18MNMS02 in partial fulfillment of the requirements for the award of Master of Science in Neural and Cognitive Sciences is a bonafide work carried out by him under my supervision and guidance.

The thesis has not been submitted previously in part or in full to this or any other University or Institution for the award of any degree or diploma.

Date

Adviser: Prof. Ramesh Kumar Mishra

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DECLARATION

I, Amit Singh, hereby declare that the thesis entitled "Interlocutor identity guides language selection - An eye tracking study using blank screen paradigm" submitted by me under the guidance and supervision of Professor Ramesh Kumar Mishra. Is a bonafide work. I also declare that it has not been submitted previously in part or in full to this University or any other University or Institution for the award of any degree or diploma.

Date

Signature of the Student

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Abstract

Keywords: *Bilingualism, Awareness, Interlocutor Identity, Language Selection, Blank Screen Paradigm, Proficiency, Externalism*

Bilinguals show a robust adaptive behaviour when it comes to the selection of a language in real-world interactional context (Green & Abutalebi, 2013). Both linguistic and non-linguistic cues help in achieving this goal. Studies show that proficient bilinguals exploit visual cues to select one language between two in a context-dependent manner (Hartsuiker, 2015). These visual cues maybe people's faces, cultural icons, celebrity pictures or ethnicity (Hartsuiker & Declerck, 2009; Jared et al., 2013; Li et al., 2013; Martin et al., 2011; Zhang et al., 2013). What facilitates the choice of language while interacting with interlocutor having a different linguistic background with ease? This thesis examines the role of non-linguistic visual cues (e.g. Interlocutor Identity) in determining the language selection in high proficient bilinguals. The previous study has established that interlocutor identity affects language activation in bilinguals (Molnar et al., 2014; Kapiley & Mishra, 2018). However, most study uses the lexical decision task which indexes the lexical access, not language selection. In contrast, the current eye-tracking study attempts to explain the language selection in an interactional context by tagging a particular interlocutor with a language. Present result shows that the linguistic background of interlocutor serves as one of the most salient cues in guiding language selection in bilinguals. Moreover, this effect is robust to an extent that even in the absence of the addressee the participants tend to look to the blank space where interlocutor was previously present. This effect is verified by "Blank Screen Paradigm" (Altmann, 2004). In this study, high proficient Hindi-English participants listened to a word in either English or Hindi only after the familiar interlocutor (high L2 proficient or low L2 proficient) has been displayed and removed from the screen. The fixation patterns unveil the preferred tagging of empty space associated with high L2 interlocutor with second language. The result is consistent with the previous finding and support for the role of the external visual environment in addition to internal linguistic brain representations in modulating language selection (Spivey et al., 2004). The spatial indices to the visual environment do not only represent perceptual-motor processing but can also account for higher-order cognitive processes like interlocutor awareness in naturalistic conversation. Moreover, the results extend to the idea of externalist philosophy of mind in which the mental content is not solely defined by the internal neural representations but also by the active role of the external environment (Clark Chalmers, 1998).

Contents

List of Figures

Chapter 1

Introduction

At the very moment, we see a familiar face we know which language to use out of the different language systems we have. This process is achieved effortlessly and appears to be automatic in day to day life (Costa, Caramazza, & Sebastián-Gallés, 2000; Van Hell Dijkstra, 2002). How are we able to select the appropriate language from this system as soon as we start a conversation or maybe way before even speaking? Previous findings suggest that people extract linguistic and visual cues during language processing which guides language selection proactively. Contextual information also plays a vital role to facilitate this process. To understand this fascinating characteristic of human communication system one needs to investigate the organisation and underlying processes on which this system is built. In bilingualism, the organisation of two languages and its access have been a topic of debate in literature for a long time. So far two different theories for the organisation and access to bilingual lexicons have been proposed; Integrated and Independent / Selective and Non-selective. Different bilingual models are built upon these ideas and capture some of the bilingual processes. Most of the theories support for the Integrated and Non-selective access to the bilingual lexicon. And this appears intuitive. Experiments suggest that bilinguals activate both their languages at different levels while processing one language (Bialystok et al., 2009). Having an integrated lexicon organisation and non-selective access poses a challenge to appropriately select one language without the interference of others. However, high proficient bilinguals overcome this challenge with ease and they efficiently switch between the languages without any difficulty. Such an adaptive behaviour has been highlighted in Adaptive Control Hypothesis (Green & Abutalebi, 2013). It proposes that bilinguals are sensitive to different interactional context (single language, dual-language and dense code-switching) and adapt to the task demands while selecting a language by using linguistic and non-linguistic cues. Furthermore, it has been established that the speaker will choose a particular language not only based upon the suitability to the interlocutor (whether he/she can speak it) but also the language in which the interlocutor is more fluent (e.g. he/she can speak English better than Hindi). The preference of a particular language over others while interacting with an interlocutor is ascertained by past experiences or familiarity. Speakers also tend to tag a particular language with specific interlocutor (Hartsuiker Declerk, 2009; Molnar, Ibáñez-Molina Carreiras, 2015). The speaker uses all possible cues (Linguistic and Non-Linguistic) in the environment to achieve the

conversation and language selection in the most parsimonious way. The visual cues are considered to be non-linguistic in the sense that it is extrinsic to the internal linguistic system and any changes in it directly affect these extrinsic cues in a context. On the other hand, the language system will try to exploit the provided extrinsic information optimally to achieve parsimonious processing. However, most models could not explain how, when and to what degree non-linguistic information (e.g. Interlocutor identity) might modulate activation patterns (Dijkstra, 2005; Dijkstra Van Heuven, 2002; Kroll, Van Hell, Tokowicz, Green, 2010). The current study takes a step forward to evaluate the degree to which language extrinsic cues (e.g. Interlocutor identity) are processed while selecting a particular language. Using Blank Screen Paradigm the study investigates the strength of non-linguistic cues which guides language selection in high proficient Hindi-English bilinguals. The study suggests that these cues are so strong that even in the absence of the interlocutor speakers tend to tag a particular language (e.g. L2) with the appropriate interlocutor.

1.1 Bilingual lexical organisation

The core theoretical issue in the bilingual language processing concerns the organisation of bilingual lexicons. One of the foundational theoretical proposals was given by Weinreich (1953) on which later models were constructed and empirically tested. This robust and simple theoretical model is based on the hierarchical levels of representations where information is organised in terms of concept and word-form. The two possible configurations between meaning and form are compound and coordinate. For compound, the concept is shared between two forms of the different language and in coordinate the two language systems are independent. For example, in compound configuration, the two forms of different language say German (Buch) and English (Book) are connected to a shared mental lexicon (Buch=Book) whereas in coordinate structure two forms are connected with independent mental lexicons (e.g. /Buch/ – Buch, /Book/ – Book). The subordinate bilingual configuration assumes that a single concept is directly linked to the form of L1 and the second language is the translation of the L1 word. And during the early phase of learning L2, the speakers associate every L2 word with the L1 word and then the lexical access takes place (Fig. 1.1). These theoretical models lay the foundation for any empirical study in bilinguals whether it is switching, inhibition or language selection. In the context of language selection in bilinguals, the question arises that at what level the language switching takes place, Conceptual or Form. The dynamic nature of these configurations does not allow these questions to be answered directly. For example, the subordinate bilinguals may achieve a compound configuration with practice (McLaughlin 1990). However, later computational and mental models developed based on these theoretical assumptions have added to the understanding of bilingual organisation and processing.

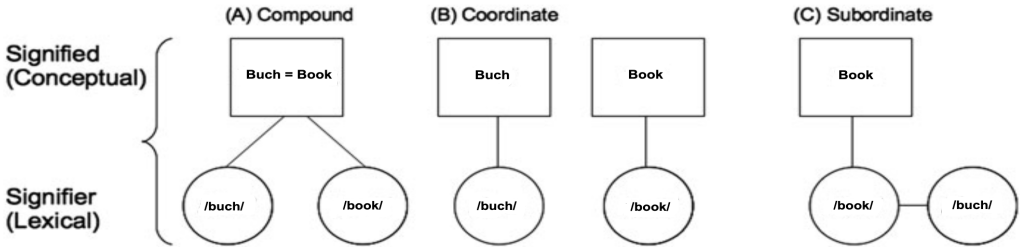

Figure 1.1 Three distinct bilingual representations configurations. (Adapted from Woutersen et al. 1994. Copyright 1994 by Cambridge University Press)

1.1.1 Integrated and Independent Lexicon

Majority of the bilingual models assume that the two lexicons are integrated and there is an activation of multiple candidates in both languages via spreading activation. The interconnected lexicons of bilinguals have an impact on the processing and access of a particular lexicon concerned with the target language. As a consequence, bilinguals have more words to chose from and these words share conceptual representation and forms e.g. homographs and homophones. Given that bilingual organisation follows interconnected configuration access of a lexicon belonging to a particular language requires either selection of target language (e.g., the Cohort model and the TRACE model) or inhibition of other languages. This organisation has been implemented and empirically established in multiple bilingual models (BLINC, RHM, BIA+). It is also found that the selection of particular language form integrated lexicon is guided by linguistic and non-linguistic cues. Recent computational models have explained this phenomenon with the network weights associated with the linguistic and non-linguistic cues at the task schema level e.g. BIA+. The independent lexicon hypothesis proposes that bilingual memory contains two different language-specific stores which is not integrated. This language-independent memory structure has shared nodes between two languages but the lexical items are organised apart. The independent lexical organisation has been not a powerful theory in bilingualism since most of the empirical studies support the coactivation of lexical candidates from both languages. However, at the conceptual level the shares semantic representation has been a most popular theory which predicts that the concept associated with two different forms are shared.

1.2 Bilingual lexical processing

The issue concerning bilingual processing is the way bilinguals gain access to their language system either from the integrated or independent lexical organisation. As already described in the previous section bilingual memory representations are considered to be integrated or independent concerning two languages present. As soon as a word is encountered in either language, the mental process of operates on those representations and lexical access takes place. Most of the current theory account for

competition among lexical candidates for lexical selection. These lexical candidates are phonological, orthographic or semantic neighbours within or between languages. The lexical processing mechanism needs to select the proper candidate and inhibit the irrelevant neighbours. The more neighbourhood candidates are activated after the initial lexical encounter the more work needs to be done by the processor to select target candidate and inhibit irrelevant neighbours. This cost is reflected in many psycholinguistic tasks e.g. lexical decision task. The processing or access of bilingual lexicon follows two pathways either selective or non-selective. This issue is widely debated in the bilingual literature. This debate is centred on two opposing views: a language selective view which assumes that a linguistic input must activate only candidates from the target language; and a non-selective access view which assumes that the linguistic input in one language will activate lexical candidates from both languages.

1.2.1 Language selective and non-selective processing

The selective-processing predicts that the processing happens within a single language system and there is no interference from the other language system. On the other hand language, non-selective access is the dominant theory which predicts that the candidates from both languages will be activated when the linguistic input is encountered. However, the type of processing hinges on the nature of the representational organisation. The nature of lexical organisation determines which pathway will be followed. For example, if the lexical organisation is integrated the selective access cannot take place. And if the lexical candidates are independent and stored uniquely then the selective access seems a viable process. Few studies show that the two hierarchical representational levels form and meaning can be organised differently. The study shows that forms are stored independently and semantics are shared between languages (see De Groot, 1998; Kroll & De Groot, 1997). Therefore the lexical access process can be distinct based upon the question asked and the representational level at which the study is conducted. Most of the prominent models are built upon the non-selective assumption and the activation pattern seems to be the function of the linguistic and non-linguistic cues provided during processing. The current study conducted in this thesis also uses the same theory to modulate the language selection based upon the non-lingustic visual cues.

1.3 Models of bilingual processing

In the last decade, the research in the bilingual literature has produced various models of bilingual lexical access. The models have been tested empirically and provided greater insight into the organisation and mental processes of the bilingual lexicon. However, the process of language selection is considered different from the lexical selection. These two processes are distinguished at the representational level. For example, BIA+ model implements nodes at two different levels for these processes. Models help in giving an insight about the representational levels and the processes which run on that particular level. Hence, several models have been developed to account for distinct bilingual phenom-

ena. To understand the language selection in interactive context evaluating models implementing those functionalities will help in conducting research and framing the hypothesis. Considering the hypothesis proposed in this thesis, models which implement representations and processes at the global language nodes are pertinent. And these theoretical and computational models of bilingual lexical access can further aid to the understanding of bilingual processing.

1.3.1 Revised Hierarchical Model

One of the prominent descriptive models in bilingual lexical access is the Revised Hierarchical Model (RHM) proposed by Kroll and Sholl (Kroll & Sholl, 1992). The model is based on the translational asymmetries observed in bilinguals. The observation that bilinguals translate from L2-L1 faster than L1-L2 has led to the development of this model. In terms of organisation, the model follows subordinate configuration () in which L1 lexicon (first language lexicon) is assumed to have larger vocabulary as opposed to L2 (second language lexicon). The link between the concept and L1 is bidirectional and stronger than the link between L2 and concept which is the result of early L1 exposure to a child. However, as a person later learns L2 in life the learning takes place via the L1 pathway where L1 serves as the basis of L2 acquisition and access to the concept. Hence, the direct link between L2 and concept is weak which necessitates the conceptual access via an L1 pathway which is already established. However, Kroll and Scholl suggest that the link between L2 form and concept can be strengthened as bilingual become more proficient and fluent in their L2.

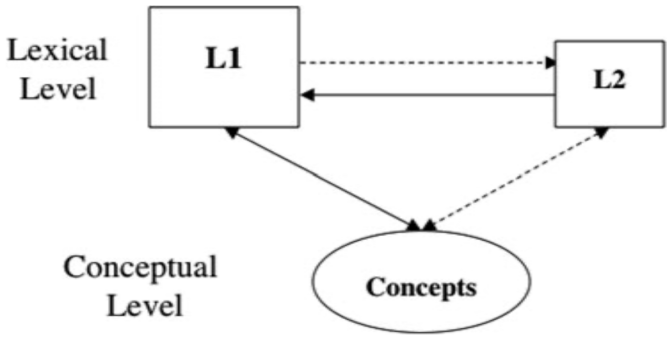

Figure 1.2 The revised hierarchical model. (Adapted from Kroll and Stewart 1994. Copyright 1994 by Elsevier)

1.3.2 Bilingual Interactive Activation Model

Earlier work in the bilingual lexical access proposed that when bilingual use one language other language shuts down. In other words, in given time only one language will be activated and selected. However, many neuroimaging studies and cognitive psychology paradigms have found that bilingual activate both their languages automatically while processing words. This led to the theory of non-selctive

activation in bilingualism and it assumes that both languages are activated during processing. The computational model, Bilingual Interactive Model (BIA, BIA+; see Dijkstra and van Heuven 1998, 2002) follows the non-selective activation. The initial model BIA was designed to account for the orthographic processing but later it was extended to phonological processing.

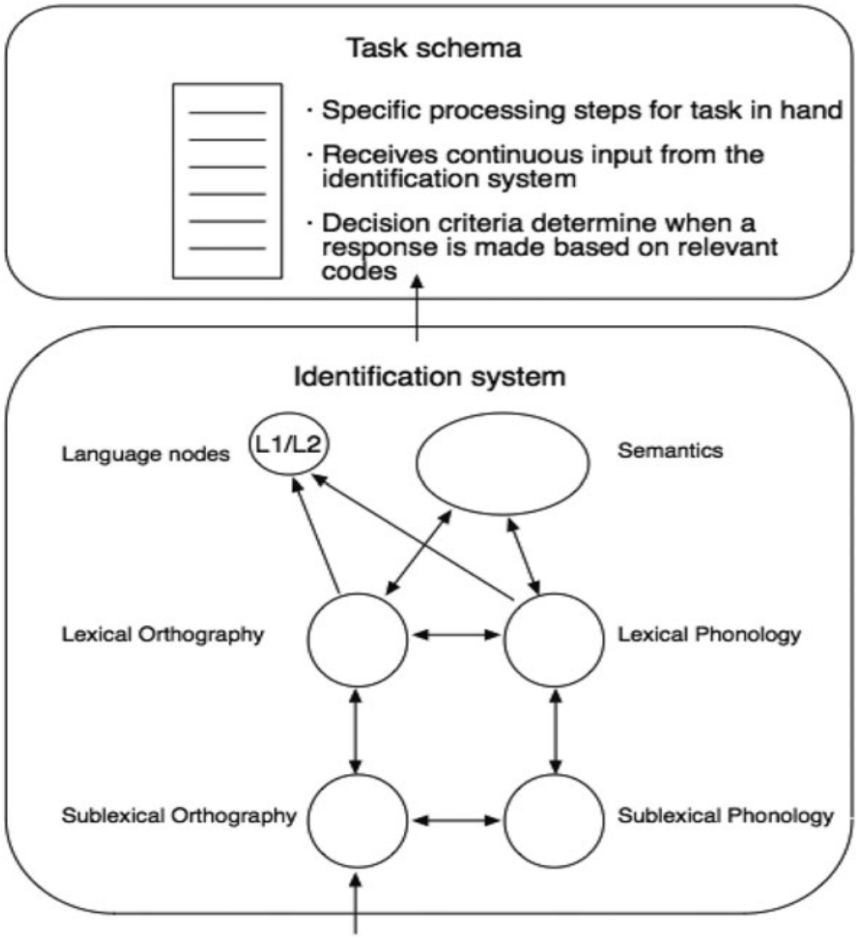

Figure 1.3 The bilingual interactive activation(BIA+) model. (Adapted from Dijkstra and van Heuven 2002. Copyright 2002 by Cambridge University Press)

When a word is presented to the model the features corresponding to the word are activated which is followed by the activation of letters associated with initial activated features. The spreading activation at the orthographic level activates the words sharing orthographies in both L1 and L2. The assumption of the model is as follows: (1) The nodes are fully connected within the level and between levels. (2) The lexicon is integrated so that there is a formation of a competitive network within a level. (3) There is a language node associated with the lexicons which account for the degree of activation for the two languages and acts as a language filter.

The model suggests that the top-down (language nodes) and bottom-up (featural processing) processes

influences word recognition. For the current study, the language node will be a crucial factor to decide the language selection in the interactional context. How and at what degree interlocutor identity influence the weights of language nodes is the theme of the current study. The task schema embedded in the model is considered to be modulated by the goal which facilitates the language selection.

1.3.3 Bilingual Language Interaction Network for Comprehension of Speech (BLINCS)

So far we have considered the models in bilingual processing which accounts for only linguistic information. However, it is already established that non-linguistic visual information affects concurrently the lexical processing in bilinguals. To account or the visual cues, the BLINC model integrates the visual module to the semantic and at the perceptual level. This connectionist model is a Self Organising Map whose nodes are fully connected within and between levels. The model does no implement global language identification nodes but it serves as a potential model to give an insight into the organisation of bilingual lexicon.

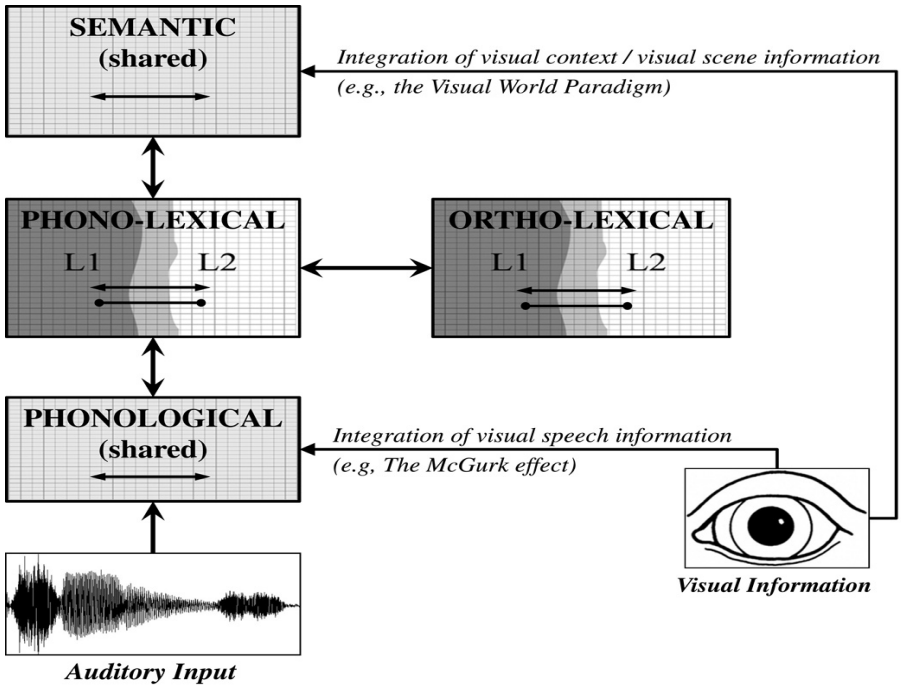

Figure 1.4 The Bilingual Language Interaction Network for Comprehension of Speech (BLINCS). (Adapted from Anthony Shook and Viorica Marian, 2014)

1.4 Zooming into the right language

Given that the bilingual language processing follows the non-selective path, restricting the processing to minimum lexical candidates and target language would be very useful. Since several studies have shown that the processor encounters difficulty when identical or similar words are encountered (e.g. cognates and interlingual homophones), restricting the processing to a limited number of neighbours will facilitate processing. For example, a study conducted by Ivanova Costa (Ivanova & Costa, 2008) suggested that monolingual speakers were faster in naming a picture of the common object as opposed to Spanish-Catalan bilinguals. Therefore it is parsimonious for the processor to restrict the processing to a particular language. Now, the central question arises that how bilingual efficiently achieve this in a complex interactional context. As Elston-Güttler, Gunter Kotz calls it "Zooming into the right language" (Elston-Güttler, Gunter & Kotz, 2005) using the available linguistic and non-linguistic cues in a context. The context contains multiple cues which is language-intrinsic (linguistic cues) and language-extrinsic (non-linguistic cues e.g. visual appearance of people). The present study proposes that the language processor is proactively watchful for both language-intrinsic and language-extrinsic cues in the context and it exploits even the weak cues present in the environment to select the target language.

1.5 Cues guiding the language selection

1.5.1 Linguistic and Non-linguistic cues

Linguistic cues affect the strength of language activation within a particular language and allow bilinguals to zoom into the target language. Various studies have highlighted that sentence context provides important cues about the language belonging of upcoming word to reduce the interference from the other language. It has also been shown in spoken word recognition literature that the speech signal contains the language-specific subphonemic component which helps in disambiguating the similar words towards the target language (Lagrou, Hartsuiker & Duyck, 2011). These studies suggest that syntactic and phonetic linguistic cues are used to zoom into the correct language associated with the target word. Moreover, various visual world paradigm studies show that semantic information does help in anticipating the language of the upcoming word. Given that the linguistic cues are strong enough to modulate language selection, the interplay between linguistic and non-linguistic cues in determining the target language needed to be explored more cautiously. These linguistic cues are subserved by visual non-linguistic cues which further facilitates the robust selection of the target language.

Non-linguistic cues A growing body of research suggests that non-linguistic cues like visual information affect language activation (Hartsuiker & Declerck, 2009; Jared et al., 2013; Li et al., 2013; Martin et al., 2011; Zhang et al., 2013). Moreover, these visual cues are directly linked to the language since interlocutor identity does modulate language selection. People visual appearance tells us directly about themselves and the language they are going to use. For example, if you interact with a person daily in English, the mere presence of him/her will automatically lead to the selection of English out

of possible languages you know. Moreover, if the person appears to be Asian, you are probably expecting him to use an Asian language. Meaning that features corresponding to a familiar face generate an expectation about the language selection. Several studies have suggested that language associated with a particular face induces the bias towards a certain language (Gollan, Schotter, Gomez, Murillo, & Rayner, 2013). In other words, the language associated with a particular face activates that particular language more than the non-target language. This effect is so robust that a short conversation with a person is sufficient to induce this effect (Martin, Vandenbulcke, Navarra, Schoonbaert, Hartsuiker, and Costa, 2011). Apart from the faces, which is too salient to bias the language choice, cultural icons can also modulate language selection which suggests that the cultural cues also plays an important role in zooming to the target language. These cues are considered to be language-extrinsic (Green, 1986; Van Heuven, Dijkstra, Grainger, 1998) and directly affect the activation of the global language node which restrict the processing to the target language.

1.6 Language cues in external environment

Research suggests that the holistic visual experience is not only achieved with the help of internal representations but the external visual environment also plays a vital role. In the context of language processing, the internal representations are linguistic and external visual experiences are non-linguistic. The external physical environment contains information which can be accessed quickly to update the concurrent information and influence the agent present in the environment. The visual information combined with the linguistic information serves to disambiguate the ambiguous signal perceptually (e.g. McGurk effect; McGurk & MacDonald, 1976). The visual information supplied to eyes are limited in both space and time how the synchronicity is achieved in external and internal representation is a core question in language and vision interface since language also unfolds with temporal constraints. To optimally exploit a region in a space the high acuity fovea must be directed towards a location in the space which contains relevant information. In the case of conversational context, the primary external cues are the facial features and interlocutor identity. And these features guide language selection from the external environment. How strongly and at what extent these external cues affect the language processing is the question which remains to be addressed.

1.6.1 Interlocutor identity affects language processing

In a natural conversational setting, the interlocutors are part of the external environment. The features or identity of interlocutors are said to influence the lexical activation patterns in bilinguals. It can be assumed that the interlocutors are embedded in the external environment and guide our linguistic behaviour. For example, many studies have found that interlocutors identity affects language choice in bilinguals. Moreover, the cultural and ethnic information associated with a particular person helps us to choose the appropriate language. Sociocultural identity of a face is also found to modulate the

language selection. One study has also investigated the external cues influences other agent's actions on voluntary switching during object naming task (Bhatia, Prasad, Sake, & Mishra, 2017). Moreover, familiarity with the language background of interlocutor modulates the language choice.

1.7 Proposed hypothesis for the study

The current study investigates the effect of non-linguistic information on language choice in high proficient Hindi-English bilinguals. Unlike the previous studies which focused on the linguistic tasks (e.g. lexical decision) to observe this phenomenon, the current eye-tracking study does not use any linguistic task which taps directly on the selectional mechanism in high proficient bilinguals in an automatic way which generally occurs in the interactional context. Based on the previous idea that speakers choose a language based on the suitability and background knowledge about the interlocutor the study takes a step further to investigate the strength of such non-linguistic external cues. The degree to which the interlocutor identity influences the language choice is remained to be investigated. Which further raises the question whether these external cues are salient enough to induce changes for a long time. Past studies have shown that a short conversation is sufficient to induce language bias based upon the interaction. The present study follows the same path and divides the study into two different phases familiarity and testing. Two different interlocutors are introduced as high and low L2 proficient speakers (L2 English). It is hypothesised that if this interactional experience is strong enough then it would not only replicate the previous findings and guides language choice based upon the interlocutor identity in presence of the interlocutor but also in absence of it. It is further hypothesised that the cues generated in the external environment in the form of abstract identity remain even after the interlocutor is not present there. Because visual processing is limited to space and time even though the bottom-up information is not present in the environment the language processor tries to extract the cues to restrict the activation to a single language considering that the bilingual activation follows non-selective activation. The blank screen paradigm further extends to the idea that these external representations are not solely retrieved from inside rather from directly outside which is automatically extracted as soon as the necessity arises. Moreover, the results extend to an idea of externalist philosophy of mind in which the mental content is not solely defined by the internal neural representations but also by the active role of the external environment (Clark & Chalmers, 1998).

Chapter 2

Blank Screen Paradigm

2.1 Introduction

A collection of eye movement experiment suggests the role of the external visual environment in visual, language memory and naturalistic conversation. Moreover, in the visual world paradigms, the eye movements are not only depended on the concurrent visual scene but are also depended upon the mental record which is independent of the visual scene still present (Altmann, 2004). Studies suggest that the spatial pattern of absent stimuli can influence eye movement pattern when features associated with it is recalled or imagined (Spivey, Richardson, Fitneva, 2004). For example, Richardson and Spivey (2000) have shown that the eyes will, under certain circumstances, move to where information had previously been introduced. The idea is linked to visual imagery. Neisser (1967) suggested that imagining activates a "top-down" process of perceptual representation which influences the eye movement. This is also true for language processing since several studies have found the same fixation patterns in blank screen paradigm and visual world study with objects in the scene. It suggests that in visual world paradigm even when the visual scene is concurrent with a linguistic expression the fixations might not refer to the actual location of that item within the scene, but on the location of that item as represented within a mental representation of the scene.

2.1.1 Blank Screen Paradigm in Language processing

In the visual world study conducted by Altmann (Altmann, 2004) instead of presenting the visual scene and target word concurrently the visual world items were presented first and then followed by the target sentence. The anticipatory eye movements were consistent with the previous findings of Altman and Kamide (1999) which suggested that anticipatory eye moments to the objects in the scene in presence of linguistic input is independent of the physical presence of the object but it is contingent upon the mental representations of the spatial indexes of the objects in the scene. Moreover, the fixations followed the temporal pattern as the linguistic information unfolds in the absence of the visual stimulus. How the blank screen was able to constrain the fixation? One possibility is that the visual system follows

a strict spatial and temporal constraints and very little information are maintained internally when eyes move to different areas on the screen. One prominent theory by Richardson and Spivey (2000) which is based upon the idea of O'Regan (1992) is that the external visual environment itself acts as an external memory which can be accessed using the oculomotor coordinates as pointers towards the cues within the scene (Ballard, Hayhoe, Pook, & Rao, 1997). This suggests that the blank screen paradigm is a robust method to evaluate the effect of visual internal and external representations on language. The paradigm is suitable to understand the interplay between the visual representations which are inside the brain and the visual information which is extracted only in the presence of the bottom-up stimulus.

2.1.2 Extending the idea to Externalism

Now, since it has been established that Eye movements that are triggered during linguistic expressions are not contingent on an item being co-present with that expression, understanding these phenomena require the investigation into the memory system. As already suggested by O'Regan (1992) that the external environment acts as a memory system, how and when the information present in this storage is accessed needed to be evaluated. It is further suggested that the visual environment can be treated as a memory database and eye-movements can extract the data from it. And the eyes scan through this external memory and organise high-level cognitive processes. The idea is consistent with the externalist philosophy of mind, in which the mental content is not solely defined by the internal neural representations but also by the active role of the external environment (Clark Chalmers, 1998). And the information from the external environment can be access as quickly as from the internal memory. Recent ideas from externalism argue that the mental experience is constructed through the immediate participatory role of the environment, this is known as active externalism (Clark & Chalmers, 1998). Moreover, O'Regan and Noë (2001) claim that "activity in internal representations does not generate the experience of seeing. The outside world serves as its own, external, representation." The pointers in the external world are the only way to access the external memory and cognitive system uses those labels to access those content. One of the most famous studies called "Hollywood Squares" (Richardson & Spivey, 2000), in this study the four characters appeared in either of the four quadrants of the screen and recited some arbitrary facts then disappeared. The participants were asked some questions regarding the uttered facts, crucially, participants looked on the quadrant where the character was present previously.

The finding suggests that the visual system looks for the deictic pointers in the external environment in absence of the characters because it helps to offload the working memory and the information from the outer world itself acts as the deictic pointers to facilitate recall. Thus, when the label of one of the pointers is called to make an attempt to access the relevant information in a context, the information is extracted from all the possible cues, external environment, pointer's address in the external environment and from internal working memory. This is also true for language processing and in interactional context.

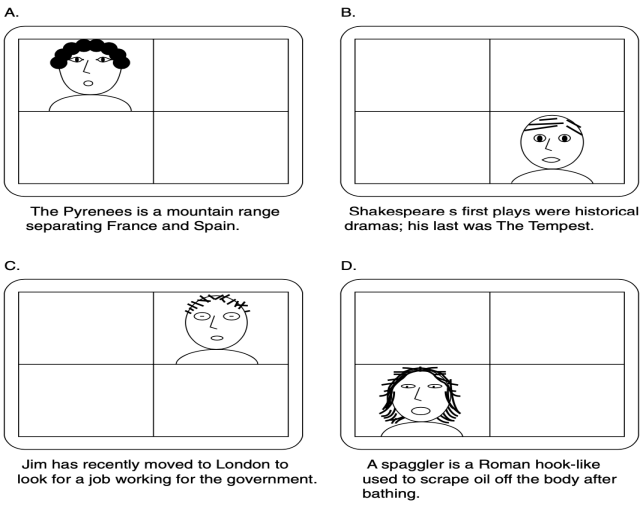

Figure 2.1 The 'Hollywood Squares' experiment", Richardson and Spivey (2000)

2.1.3 External memory in language processing

The organisation of sensory input by using space is helpful in language processing as well. As mentioned earlier space acts as an external memory onto which the information is organised and accessed when required. Moreover, access to information from this external space is considered to be automatic and fast. This property for the memory aligns well with the language processing module in humans because most linguistic phenomena appear to be automatic and fast. The previous study in memory, attention and action suggest that by using the external memory one offloads the working memory and the language uses working memory as a core component. Hence, using the external memory simultaneously with internal representation while language processing can have two prominent effects on the overall language processing. (1) Relying partially on external memory will automatise the language processing task. (2) The cues present for disambiguation at the perceptual or decisional level will enhance and hence aid the language processing. Maintainance of multiple indices in space helps in naturalistic spoken conversation (e.g. Gestures). Also, studies on American Sign Langauge studies suggested that the assigning the particular space for an action verb helps in extracting the meaning at the discourse level. The concept of external memory is exploited mostly in the naturalistic conversational setting. And the language processor uses these indexical cues in the environment to aid the understanding. Moreover, the spatial indexing system is constantly looking for the potential information in the external physical environment even if the object goes off the environment and treating it as a potential source of information to be used while processing and as if the object is still there and it is waiting for its content to be addressed. The present study uses this idea to investigate bilingual processing.

Chapter 3

Eye-tracking study using blank screen paradigm

3.1 Introduction

Parallel activation of non-selective linguistic information has been widely studied in Bilingualism. This phenomenon is found in both directions L2-L1 and L1-L2 as well as at various levels of linguistic representations (e.g. Orthography, semantics or phonological form). Visual world studies have also shown that participants activate information in both their languages with audio-visual input. Interactional context plays a very key role in the selection of the target language out of the two systems of languages available in bilinguals. Consistent with this idea many studies have found the effect of non-linguistic interlocutor characteristics (e.g. Face, ethnicity and proficiency) constraint language selection. However, very few studies have investigated the effect of interlocutor proficiency on cross-linguistic parallel activation. Since language is a social phenomenon every interlocutor is tagged with certain language proficiency either in L1 or L2. The awareness about interlocutor's proficiency seems more natural and perceived unconsciously in daily life without much effort. Bilinguals choose their language based on the context and the interlocutor they are interacting with. Given that the two languages are in close competition for selection which language is used consequently depends upon both linguistic and non-linguistic cues present in the environment. Theory suggests that speakers evaluate the proficiency of the interlocutor and selects the language in which the interlocutor is more proficient. The theory is adopted in the Adaptive Control Hypothesis (Green & Abutalebi, 2013). The non-selective activation pattern necessitates the optimal use of cues present in the environment to weight the language selection. Such a mechanism has been implemented in a computational model like BIA+. This model incorporates two global nodes for language selection at the task schema level and based on the maximum weight of the modes a particular language will be selected. Crucially, the model assumes that linguistic and non-linguistic cues are the most important factors in guiding those selections. In this study, we try to evaluate the effect of a non-linguistic cue like interlocutor proficiency on modulating the global language selection in high proficient Hindi-English bilinguals. Using eye-tracking the effect of interlocutor proficiency on language choice is evaluated. Unlike the past studies where the selection mechanism is evaluated based on psycholinguistic production or comprehension task, the present study uses a popular

paradigm known as Blank Screen Paradigm to investigate the extent to which the non-linguistic cues (like interlocutor proficiency) affects language choice in high proficient Hindi-English bilinguals. The result suggests that speakers tend to fixate more on the high proficient L2 interlocutor when a word in L2 is presented after the offset of interlocutor from the screen. Crucially, this effect even found in the absence of the interlocutor i.e., on the blank screen. The study connects to the popular theory in philosophy of mind called Externalism (Clark Chalmers, 1998).

3.2 Method

3.2.1 Participants and Stimuli

Participants

Sixteen Hindi (L1) – English (L2) bilinguals from the University of Hyderabad community (8 male, 8 female, Mean-age = 23.5 years, SD = 2.6 years) participated in the main experiment. All the participants were students at the University of Hyderabad and voluntarily participated in the study by providing their written consent. The study was approved by the institutional ethics committee (IEC) at the University of Hyderabad.

Language environment in the university

The lingua franca of the university is English, L2 of all participants. Since the University of Hyderabad is a big research university of national importance, most students who come here are fluent in English (L2) apart from their mother tongues. However, we selected only speakers who had Hindi (L1) as their first language. All the teaching and instruction at the university is in English, which also influences the choice of language during conversations.

Control task

The participants were tested on the Lextale (Lemhöfer Broersma, 2012). Lextale is an online vocabulary test. The task was done to measure the L2 proficiency (English) of the participants. Participants' mean score on the Lextale test was 49.43 percent, (SD = 12.73 percent). The lextale task followed a semantic fluency task to evaluate the language fluency in L1 (Hindi) and English (L2). In this task, speakers were asked to produce as many words as they could in two different categories. For word generation in Hindi (L1) the categories "vegetables" and "birds", and for English (L2) "fruits" and "animals". Categories were counter-balanced between languages. We calculated the number of words produced per minute in each language for each category and the scores was averaged out for two categories for each language. The semantic fluency score in English (L2) (M = 15.32, SD = 3.14) was significantly higher than Hindi (L1) (M = 10.09, SD = 2.3), t(1, 30) = 5.3748, p ¡ 0.0001. To administer, the demographic details and language used by participants in both L1 and L2 a language questionnaire were used. The questionnaire was based on the scores on language proficiency, current use of language and age of language acquisi-

tion (see LSBQ, Anderson, Mak, Chahi, amp; Bialystok, 2017). The factor score of English (L2) (M = 0.02, SD = 1.09) was significantly higher than Hindi (L1), (M = -0.23, SD = 0.8), t(1, 30) = 7.03, p ¡ 0.001. It suggests that participants were more proficient in English than in Hindi.

Stimuli

Four cartoon male avatars were created to act as an interlocutor in the study. Two bilinguals Hindi (L1) and English (L2) were asked to record the words in English and Hindi to be used in the main auditory-visual experiment. Additionally, 10 questions each were also recorded in English and Hindi to be used in the familiarisation phase of the task. Crucially, the set of questions were recorded by one high proficient and one low proficient (L2) bilingual. The interlocutors were lip-synced with the questions and 10 video clips were generated for high proficient and low proficient cartoons each. The videos were made realistic by adding lip movement and eye blink. Overall four cartoon was created for the eye-tracking experiment 2 for different language condition and two for the neutral condition. Each of the cartoons from the language condition was lip-synced with high proficient voice or low proficient voice. The cartoons asked question in both languages English (L1) and Hindi (L2). However, the distribution of languages between cartoons was made uneven to make a cartoon appear more proficient in L2 than others. For example, low proficient L2 cartoon asked more questions in L1 than in L2. And since the L2 voice sample was recorded by a low proficient English speaker there were occasional grammatical mistakes.

3.2.2 Procedure

The experiment was divided into two phases Familiarization and Testing. The participant was seated on the chair in a quiet room with a headset. In the familiarization phase, first, the two cartoons were presented and given a brief introduction. Then the participants interacted with the cartoons by answering the questions asked by the cartoon in the same language. Each cartoon asked day to day life questions either in English or in Hindi, there was no within utterance switch of language in either condition. The order of the presentation of the cartoons was counterbalanced between the participants. The total number of video clips in each condition was 10 making altogether 20 questions to be answered. The cartoons remained on the screen until the participant pressed the button to change the clip. The familiarisation session lasted for 20 minutes.

After the familiarisation phase, the eye-tracking study was conducted in the same room. Participants were seated on the chair in a quiet room. Eye movement data were recorded using a desktop mounted Eyelink 1000 eye-tracker (SR research, Ontario) with a sampling rate of 1000 Hz under binocular viewing. Participants rested their head on a chin rest for stable viewing. A 9-point calibration was used for each participant. Stimuli were presented on a 19 inch LCD monitor with a refresh rate of 60 Hz placed at a distance of 60 cm from the participant. Participants first saw a fixation 1000 ms on each trial. Then two interlocutors one high proficient and one low proficient was presented in two half of the screens for 3000 ms. (Adopted from Kapiley and Mishra,) in language conditioned trial. Two neutral cartoons

were presented in the neutral condition in both quadrants. After the offset of the cartoons, the auditory word was presented in either Hindi (L1) or English (L2). In some trials, participants were given a word on the screen which either matches or does not matches with the spoken word. The task was to press the spacebar on the keyboard if it matches. There was no time constraint for this task, it was just to make sure that the participant pays attention to the screen. The eye movement data were recorded in the blank screen interval. A total of 160 trials equally divided between experimental and neutral condition. The participants were presented with a total of 4 blocks of trials blocked across condition and language (Hindi or English). The block was randomised across participants. The order of presentation of the blocks was randomised at each level of blocking such that participants first encountered all trials with L1 spoken word or all trials with L2 spoken word. Within each language direction, the order of presentation of language conditioned and neutral blocks was then randomised.

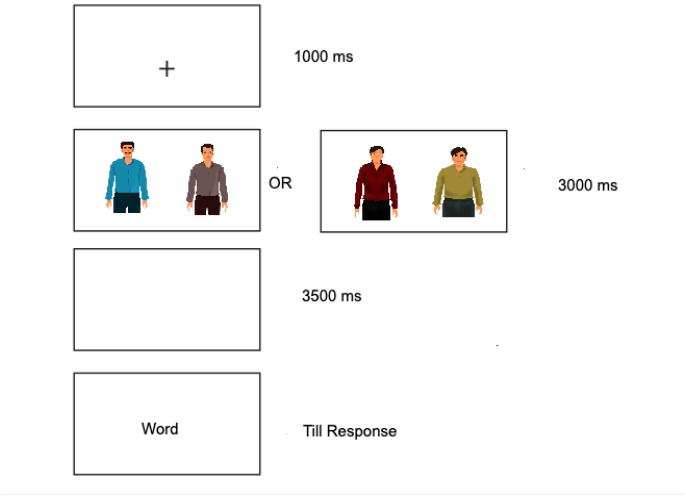

Figure 3.1 Trial Sequence in two different conditions; Neutral and Bilingual Interlocutor)

3.3 Data Analysis

3.3.1 Fixation analysis

Eye movement data were extracted using DataViewer (SR Research, Ontario) for analysis. The screen size was divided into two equal quadrants (based on the analysis procedure of Mishra Singh, 2014, 2016). The interest period was taken from the offset of the cartoon until the onset of the word for 3500 ms. Fixations were counted only during the blank screen period. The proportion of fixation was calculated to each quadrant by counting the number of fixation in each interest region and dividing it by the total number of fixations the fixations having a duration less than 200 ms was not included in the analysis since, the lower limit of 200 ms was chosen as that is the minimum time required to program

and launch a saccade (Saslow, 1967) based on previous visual world studies (e.g. Altmann Kamide, 2004; Mercier et al., 2014). Looks to the regions were analysed by considering the log transforms of fixation proportion as the dependent variable and language type, Interlocutor Type and condition (Neutral vs Bilingual) as fixed effects. The neutral condition was taken as the baseline. Two different mixed-effects models each for two different conditions (Neutral vs Bilingual) was fitted on the filtered data by taking fixation proportion as the dependent variable and Spoken language, type of interlocutor as an independent variable.

3.4 Results and Discussion

Results

Results as presented for (1) Bilingual Interlocutor Condition (2) Neutral Condition

The analysis was done on python's statsmodel OLS (Seabold, Skipper, and Josef Perktold, 2010). The analysis for the mean proportion of fixation to the two interlocutor type showed that the fixation to the high proficient bilingual was significantly higher compared to the low proficient interlocutor in bilingual interlocutor condition (= 0.45, SE = 119, t = 3.8, p-value 0.000). In neutral condition there was no main effect of interlocutor type on proportion of fixation (= -0.11, SE = 134, t = -771, p-value 0.441) indicating that there was no bias towards any interlocutor in neutral condition. However in both conditions there was main effect of langauge. (Bilingual: = 0.63, SE = 119, t = 5.3, p-value 0.000 Neutral: = 0.49, SE = 135, t = 3.63, p-value 0.000). The two way interaction analysis indicated that there was a significant interaction between language and interlocutor type in bilingual condition (= 1.63, SE = 26, t = 6.12, p-value 0.000). (See fig.)

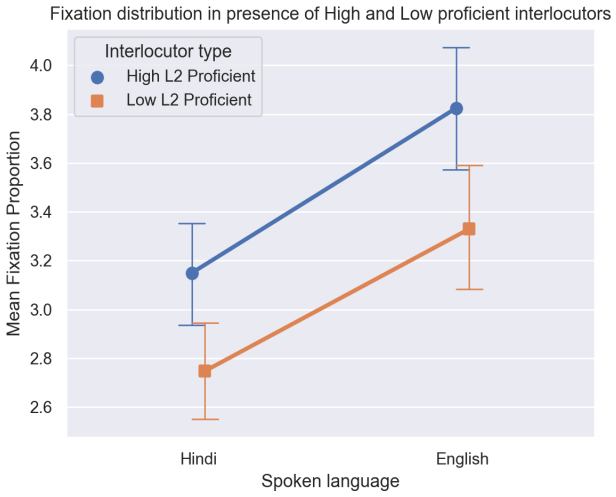

Figure 3.2 Fixation proportion on blank screen in presence of High and Low proficient interlocutors

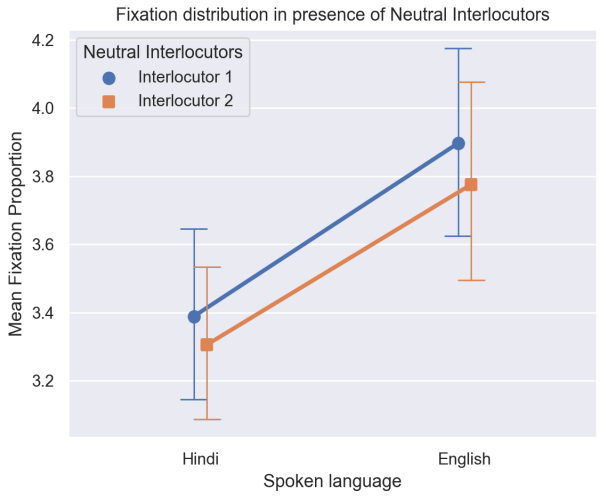

Figure 3.3 Fixation proportion on blank screen in presence of Neutral interlocutors

Discussion and Conclusion In this experiment, we examined whether non-linguistic cues (interlocutor proficiency in L2) modulate language selection in high-proficient Hindi-English bilinguals. Crucially, the fixation was analysed in the period when there was nothing on the screen. The data strongly suggest that bilingual's language choice is affected by the L2 proficiency of the interlocutor. When presented with English word participants are more likely to fixate on the location where high L2 proficient bilingual was present previously. The data also suggest that the location tagged with particular interlocutor acts as a salient cue which can guide language selection. Importantly, in both condition, there were overall more fixations on the bilingual interlocutor which suggest that they choose high proficient bilingual more number of times. The result is consistent with the past studies () but the current study extends the previous idea to the blank screen paradigm. The previous study shows that participant tag certain language with particular interlocutor (Molnar et al., 2015). The current study takes a step forward to illustrate that this preferential tagging of a language with an interlocutor can also take place in the absence of the interlocutor. The bilinguals established a strong association between language and interlocutor and this association is so strong that even after the interlocutor disappear from the outer space the cues can guide fixation patterns. The present study suggests that non-linguistic cues present in the visual environment affect the language representations stronger than linguistic cues. The literature uses cognate effects and homographs to investigate the effect of these cues on non-selective processing and few studies use non-linguistic cues to evaluate the selection mechanism. The result adds to the previous results of non-selective activation with a more weightage to non-linguistic cues in modulating the language selection. Crucially, the present study only accounts for the results obtained in the absence of the bottom-up stimulus. Hence, it further supports the idea that surrounding environment potentially serves as a memory which holds the current object and also the object which was previously present there. And fixations are used to access those external data following this process the external

memory complements the internal memory. One theoretical proposal with the external memory is that it is quickly accessed sometimes faster than the internal memory. The idea seems intuitive in an interactional context where as soon as one meets a person the language selection seem automatic. However, most non-selective activation model suggests that language selection requires inhibition and selection simultaneously which is a resource-demanding task. These two different views can be understood in terms of internal and external representations. As suggested by the current study non-linguistic cue like interlocutor awareness is not a part of internal linguistic representation hence it is accessed fast without any competitions however on the other hand linguistic representation are internal and it needs conscious evaluation before selecting a candidate from the possible neighbours. The interplay between both internal and external representations give rise to a holistic conversation in an interactional environment. Future studies in psycholinguistics should try to disentangle these representations and should attempt to understand these components in the context of language and vision.

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Additional materials / tables

OLS Regression Results

Dep. Variable:	Fixation_Count	R-squared:	0.028
Model:	OLS	Adj. R-squared:	0.027
Method:	Least Squares	F-statistic:	20.77
Date:	Wed, 03 Jun 2020	Prob (F-statistic):	1.28e-09
Time:	19:54:46	Log-Likelihood:	-3173.0
No. Observations:	1426	AIC:	6352.
Df Residuals:	1423	BIC:	6368.
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	1.6377	0.267	6.123	0.000	1.113	2.162
interlocutor	0.4518	0.119	3.800	0.000	0.219	0.685
language	0.6311	0.119	5.300	0.000	0.398	0.865

Omnibus:	230.881	Durbin-Watson:	0.708
Prob(Omnibus):	0.000	Jarque-Bera (JB):	365.900
Skew:	1.087	Prob(JB):	3.51e-80
Kurtosis:	4.195	Cond. No.	11.9

Figure 3.4 Mixed model regression result for Bilingual Condition; DV: Fixation Proportion, IV: Language , Interlocutor; Module: Python Statsmodel API, https://www.statsmodels.org/stable/index.html

OLS Regression Results

Dep. Variable:	Fixation_Count	R-squared:	0.009
Model:	OLS	Adj. R-squared:	0.008
Method:	Least Squares	F-statistic:	6.925
Date:	Wed, 03 Jun 2020	Prob (F-statistic):	0.00102
Time:	19:56:28	Log-Likelihood:	-3439.6
No. Observations:	1458	AIC:	6885.
Df Residuals:	1455	BIC:	6901.
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	3.0142	0.300	10.047	0.000	2.426	3.603
interlocutor	-0.1035	0.134	-0.771	0.441	-0.367	0.160
language	0.4888	0.135	3.627	0.000	0.224	0.753

Omnibus:	265.165	Durbin-Watson:	0.580
Prob(Omnibus):	0.000	Jarque-Bera (JB):	437.762
Skew:	1.189	Prob(JB):	8.73e-96
Kurtosis:	4.245	Cond. No.	11.8

Figure 3.5 Mixed model regression result for Neutral Condition; DV: Fixation Proportion, IV: Language , Interlocutor; Module: Python Statsmodel API, https://www.statsmodels.org/stable/index.html