

The Role of Interactional Context in Modulating Executive Control

A thesis submitted during 2021 to the University of Hyderabad in
partial fulfillment of the award of a Ph.D. degree in Centre for Neural and Cognitive Sciences

by

Riya Rafeekh



Centre for Neural and Cognitive Sciences

School of Medical Science

University of Hyderabad
(P.O.) Central University,
Gachibowli, Hyderabad – 500 046

Telangana

India



CERTIFICATE

This is to certify that the thesis entitled “**The Role of Interactional Context in Modulating Executive Control**” submitted by **Riya Rafeekh** bearing Reg. No **16CCPC03** in partial fulfillment of the requirements for the award of Doctor of Philosophy in Cognitive Science is a bonafide work carried out by her under my supervision and guidance.

This thesis is free from plagiarism and 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.

Further, the student has the following publication before submission of the thesis for adjudication and has produced evidence for the same in the form of acceptance letter or the reprint in the relevant area of her research.

Rafeekh, R., & Mishra, R. K. (2021). The sensitivity to context modulates executive control: Evidence from Malayalam–English bilinguals. *Bilingualism: Language and Cognition*, 24(2), 358-373

Papers presented during National and International Conferences:

Rafeekh, R., & Mishra, R. K. (2019, September). *Does Interactional Context Modulate Conflict Resolution? Evidence from Oculomotor Stroop Task*. 25th International Conference on Architectures and Mechanisms of Language Processing (AMLaP), National Research University Higher School of Economics, Moscow, Russia (Poster)

Rafeekh, R., & Mishra, R. K. (2018, November). *The interlocutor's L2 proficiency modulates conflict monitoring: Evidence from Flanker task*. International Symposium on Bilingualism and Cognition, Birla Institute of Technology & Science Pilani – KK Birla Campus Goa, India (Oral)

Further, the student has passed the following courses towards fulfilment of coursework requirement for Ph.D:

No	Course Code	Name	Credits	Pass/Fail
1	CO-801	Statistics and Research Methodology	4	Pass
2	CO-802	Foundation of Neuroscience	4	Pass
3	CO-803	Foundation of Cognitive Science	4	Pass
4	CO-804	Lab course for three theory course	4	Pass


Supervisor

Ramesh Kumar Mishra
Professor and Head
Centre for Neural & Cognitive Sciences
University of Hyderabad
Hyderabad-500 046. INDIA


Head of Department

Ramesh Kumar Mishra
Professor and Head
Centre for Neural & Cognitive Sciences
University of Hyderabad
Hyderabad-500 046. INDIA

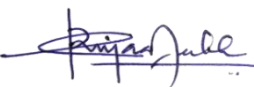

Dean of School
संकाय अध्यक्ष
Dean
चिकित्सा विज्ञान संकाय
School of Medical Sciences

DECLARATION

I, **Riya Rafeekh**, hereby declare that this thesis entitled “**The Role of Interactional Context in Modulating Executive Control**” submitted by me under the guidance and supervision of Professor **Ramesh Kumar Mishra** is a bonafide research work. I also declare that it has not been submitted previously in part or in full to this University or any or any other University or Institution for the award of any degree or diploma.

Date : 05.05.2021

Name : Riya Rafeekh

Signature of the student: 

Regd. No. 16CCPC03



University of Hyderabad

Certificate of Title

Enrolment No. 16CCPC03

Name of the Scholar: Riya Rafeekh

Course of Study: Ph.D. Cognitive Science

Title of the Thesis/dissertation/project: The Role of Interactional Context in Modulating
Executive Control

Name of the supervisor: Prof. Ramesh Kumar Mishra

Department/School: Centre for Neural and Cognitive Science,
School of Medical Sciences

Date: 05.05.2021

Controller of Examinations

Acknowledgements

I would like to express my deepest gratitude to my supervisor, Prof. Ramesh Kumar Mishra, who helped me in all the stages of this work. Without his support and help, I would not have been able to submit the thesis. I find him inspiring in terms of his scientific temper and his constant engagement in academics. I am and will always be grateful to Prof. B. R. Shamanna, one of the members of my doctoral adversary committee. He gifted me with wonderful insights and comments regarding several of my experiments. I would also like to thank Dr. Gouri Shankar Patil who was also a member of my doctoral committee for his support and encouragement.

I am deeply indebted to Seema Prasad, my friend and colleague. I would not have been able to complete my thesis without her unwavering support, insights and constructive criticisms. A sincere thanks to Keerthana Kapiley for the practical suggestions and for being a wonderful friend. I had great pleasure working with all the members of the Action Control and Cognition Lab. In particular, thank you Aniruddha for the lunch breaks and dinners, and for listening to me talking about bilingualism. Thank you to all the faculty and students at the Centre for Neural and Cognitive Sciences.

I would like to thank my dear friend, Anakha Ajith for listening to me in all situations and for putting up with me. A special thanks to Irfan Habeeb for being a patient listener and for reminding me to enjoy every moment. My heartfelt thanks to Vimal and Arya for being there whenever I needed them. Thanks to Sreerakuvandana for making this journey easier.

I am extremely grateful to my parents, Dr. P. Mohammed Rafeekh and Dr. Vaheeda K. I, for their relentless support, nurture and encouragement throughout my life. Thanks to my sister Dr. Liya Rafeekh for the constant nagging and motivation, and for being there during the ups and downs. A special note of thanks to Dr. Shamal AL Otaibi for proofreading the whole thesis in such a short time to make it more legible. I also thank my extended family members, especially Rania, Safa, Aysha and Dr. Ashika for all the long-distance calls and support.

The biggest thank you of all goes to my companion, Dr. Harshan T P for always being there with endless patience. A whole book would not suffice to tell you how grateful I am!

A million thanks to all my study participants for their time and perseverance in finishing all my long and arduous tasks without complaint that allowed me to conduct the experiments.

Finally, I would like to thank everyone who, whether they know it or not, has had an impact on this work and my journey as a Ph.D. student.

Abstract

The ability to adapt behaviour to ever-changing environmental demands is the defining feature of social cognition. An example of such a capability is bilinguals' capacity to switch languages depending on the interlocutor's linguistic profile, assisted by cognitive control mechanisms. Does managing multiple languages in everyday life affect the executive functions? Recent works suggest that the differences in bilingual experiences can influence language-related processes and domain-general cognitive control mechanisms. The series of studies presented in this thesis target how bilingual language-related experience modulates cognitive control mechanisms and what factors contribute to it. The thesis is aimed at exploring how different interactional contexts modulate executive control; the interactional contexts were incorporated in the experiments by presenting cartoon interlocutors with different second language proficiencies. The thesis further attempts to link how variations in bilingual experiences, for instance, language use and exposure, regulates the relationship between interactional context and executive control. The results unveil novel patterns of executive control regulation while adapting to various interactional contexts. Specifically, the second language proficiency of the bilinguals, exposure and use of the second language, and the language identity of the interlocutor (within the interactional context) modulates cognitive resources. Taken together, the thesis illustrates the nature of cognitive control mechanisms and the need to consider bilingual experience in understanding social cognition.

Table of Contents

Acknowledgements.....	vi
Abstract.....	viii
List of Tables	xiii
List of Figures.....	xiv
Abbreviations.....	xvi
Chapter 1: Introduction	1
1.1 Social interaction and executive functions.....	3
1.2 Bilingualism and executive functions	5
1.3 Bilingual language experience and control	10
1.3.1 Adaptive control hypothesis (ACH).....	12
1.4 Cross talk between interactional context and control.....	14
1.4.1 Interactional Context and bilingual language control.....	15
1.4.2 Interactional Context and executive control.....	16
1.5 The neuroscience of social cognition.....	17
1.6 Motivation	19
1.7 Objectives.....	23
1.8 Overview of the Chapters.....	24
Chapter 2: The sensitivity to context modulates executive control: Evidence from Malayalam-English bilinguals	26
2.1 Introduction	27
2.1.1 Current study.	31
2.2 Method	33
2.2.1 Participants.	33
2.2.2 Control measures.	35
2.2.2.1 Semantic fluency task.	35
2.2.2.2 WordORnot.....	36
2.2.2.3 Language Questionnaire.	36
2.2.2.4 Object naming.....	37
2.2.2.5 Composite score.....	38
2.2.3 Stimuli for the experiment.....	39
2.2.4 Procedure.	40

2.2.4.1 Familiarisation phase.	40
2.2.4.2 Interaction phase.	40
2.2.4.3 Flanker task.	41
2.2.4.4 Re-familiarisation phase.	42
2. 3 Results	43
2.3.1 Control Experiment.	47
2.3.2 Correlations.	48
2.4 Discussion	50
2.5 Experiment 2	50
2.5.1 Method.....	51
2.5.1.1 Participants.....	51
2.5.1.2 Control measures.	53
2.5.1.2.1 Semantic fluency task.....	53
2.5.1.2.2 WordORnot.	53
2.5.1.2.3 Language Questionnaire.....	54
2.5.1.2.4 Object naming.	54
2.5.1.2.5 Composite score.	54
2.5.1.3 Procedure.	54
2.5.2 Results	55
2.5.2.1 Control Experiment.....	63
2.5.2.2 Correlations.....	65
2.5.3 Discussion.....	67
2.6 General discussion.....	67
Chapter 3: Does interactional context modulate oculomotor control?	72
3.1 Introduction	73
3.1.1 Social context and eye movements.....	73
3.1.2 Interactional context and oculomotor control.....	74
3.1.3 Present study.....	76
3.2 Method	78
3.2.1 Participants.	78
3.2.2 Control tasks.	80
3.2.3 Interlocutor Stimuli.....	81

3.2.4 Procedure.	81
3.2.4.1 Oculomotor Stroop task.	82
3.2.5 Data pre-processing and analysis.	83
3.3 Results	84
3.3.1 Saccade latency.....	84
3.3.2 Error analysis.	87
3.3.3 Correlation.	88
3.4 Discussion	90
Chapter 4: Moving from Kerala to Hyderabad: Did I become better at interlocutor adaptation?	96
4.1 Introduction	97
4.1.1 Relocation and Bilingualism.	99
4.1.2 Current study.	101
4.2 Method	103
4.2.1 Participants.	103
4.2.2 Language measures.....	104
4.2.2.1 LEAP Questionnaire.	104
4.2.2.2 WordORnot.....	106
4.2.2.3 Object naming task.	107
4.2.3 Flanker task.....	107
4.3 Results	108
4.3.1 Reaction time data.	108
4.3.2 Conflict effect.	113
4.3.3 Error Analysis: Interlocutor.....	115
4.3.4 Control Experiment.	116
4.3.4.1 Conflict effect.	117
4.3.4.2 Error analysis.	118
4.3.5 Correlation.	119
4.4 Discussion	121
Chapter 5: Summary and Conclusion.....	126
References	137
Appendix A: Interlocutor Images	164
Appendix B: Characteristics of the high-L2 and low-L2 proficient interlocutors.....	165

Appendix C: Questions used in the interaction phase	166
Appendix D: Questions used in the re-familiarisation phase.....	168
Appendix E: Sample Consent Form	169
Appendix F: Language Questionnaire	171
Appendix G: Stimuli used in object naming task	177
Appendix H: Presentations related to thesis	180

List of Tables

Table 1 The relation between linguistic environment and control processes based on the ACH.	12
Table 2 Participant characteristics and language measures (Experiment 1).....	34
Table 3 Mean reaction time of the participants across the experimental condition.....	44
Table 4 Mean error rates of the participants across the experimental conditions.....	46
Table 5 Participant characteristics (Experiment 2).....	52
Table 6 Mean reaction time of the participants across the experimental conditions	56
Table 7 Mean error rates of participants in various experimental conditions.....	62
Table 8 Characteristics of participants in the study	79
Table 9 Mean saccade latency under different experimental conditions.....	85
Table 10 Mean error rates under different experimental conditions.....	88
Table 11 Participant details.....	103
Table 12 Current exposure to L1 and L2 across different contexts	105
Table 13 Mean reaction time of participants across different experimental conditions	110

List of Figures

Figure 1. The social context network model proposed by Ibañez and Manes (2012)	19
Figure 2. Possible interactive situations encountered by a bilingual and the cognitive processes involved.....	22
Figure 3. Schematic representation of Flanker task incorporated with three interactional contexts.	42
Figure 4. Conflict effect in the presence of high-L2 proficient (HP), low-L2 proficient (LP) and neutral interlocutors.	45
Figure 5. Conflict effect in the control condition across both groups of participants	48
Figure 6. Correlation between conflict effect in the presence of high-L2 proficient interlocutor (HP_E), low-L2 proficient interlocutor (LP_E) and neutral interlocutor (NT_E) with different language variables.....	49
Figure 7. Conflict effect in the presence of different experimental conditions.	60
Figure 8. Conflict effect across high and low monitoring conditions for both high-L2 proficient and low-L2 proficient bilinguals.....	64
Figure 9. Correlation between different language variables and conflict effect in the interlocutor conditions.....	66
Figure 10. Schematic representation of oculomotor Stroop task incorporated with three interactional contexts.	83
Figure 11. Stroop effect in the presence of different experimental conditions.....	87
Figure 12. Correlation between Stroop effect and language variables	89
Figure 13. Correlogram of Stroop interference effect (left) and Stroop facilitation effect.....	90
Figure 14. Language selection of a bilingual in different contexts.....	100

Figure 15. Conflict effect in the presence of high-L2 proficient, low-L2 proficient and neutral interlocutors at T1 and T2 for participants from the University of Hyderabad and the University of Kerala.....	114
Figure 16. Conflict effect in the control task across the two time points.	118
Figure 17. Correlogram depicting the relation between different variables at T1.....	120
Figure 18. Correlogram depicting the relation between different variables at T2.....	121

Abbreviations

ACH	Adaptive Control Hypothesis
ANT	Attention Network Task
EF	Executive Functions
L1	First language
L2	Second language
M	Mean value
RT	Reaction Time
SD	Standard Deviation
SE	Standard Error
T1	Time point 1
T2	Time point 2

Chapter 1: Introduction

Imagine walking into the Starbucks cafe; you will find yourself using English rather than the native language. However, if you are at the local 'next-door chaiwala' ordering a tea, you will be using the native (or local) language. The general context you are in and the conversation partners influence the language that you select to interact or communicate with. But why does this affect your language choice? Humans, being social animals, exist in a web of relationships, and the presence of other human beings can modulate the basic information processing (Cacioppo, 2002; Cacioppo, Berntson, Sheridan, & McClintock, 2000). Successful interactions often entail adaptation, incorporating the interlocutor's expectations, beliefs, identity, and conversational goals. Interpersonal activity is identified to promote higher mental functions (Vygotsky, 1980) and contribute to social, cognitive, and linguistic development (Redcay & Warnell, 2018). During a conversation between two people, both the speaker and listener act in a goal-directed manner; the speaker has to choose the appropriate words to convey the meaning or information, whereas the listener is expected to decode what is being said based on the context as well as the motives of the speaker. In the case of bilinguals, this interaction might involve using two languages and attending to environmental cues. The listener here has to manage the languages and the content and intention (of speech). Evidence suggests that various cognitive processes are involved in adapting to the changing demands of the social and physical environment and that the demands imposed by these environments in turn influence cognitive processing (Green & Abutalebi, 2013; Gullifer & Titone, 2019).

Nevertheless, many issues related to the relationship between the social environment and executive control remain unexplored. Primarily, it is still unclear what factors influence social interactions, especially interlocutor identity, and how they are linked to executive control.

Secondarily, the link between bilinguals' language experience and adaptation to the interlocutors needs further exploration. Much of the research on this (Blanco-Elorrieta & Pylkkänen, 2017; Jiao et al., 2018; Kapiley & Mishra, 2019; Molnar, Ibáñez-Molina, & Carreiras, 2015; Rafeekh & Mishra, 2020; Wu & Thierry, 2013) was inspired by the Adaptive Control Hypothesis published by Green and Abutalebi (2013). The current thesis examines how differing linguistic experiences of bilinguals influence cognitive control and explores the factors contributing to this.

Social interactions require allotment of attention to each speaker depending on the interactions and a shift in awareness to meet the demands. Processes involved during social interactions can be either bottom-up or context-driven (Costall & Leudar, 2009), top-down or goal-oriented (Schoot, Hagoort, & Segaert, 2019; Van Meel & Van Heijningen, 2010; Winter & Uleman, 1984) or an interface of both (Freeman, Johnson, Adams, & Ambady, 2012). For example, bottom-up factors like physical features, race (Sinclair & Kunda, 1999), gender (Macrae, Bodenhausen, & Milne, 1995), gestures or facial expressions (Pfabigan, Gittenberger, & Lamm, 2019), the gaze of the interlocutor (Graham & LaBar, 2007), facial emotion (Atkinson, Tipples, Burt, & Young, 2005), and top-down factors like prior knowledge (Gipson, Gorman, & Hessler, 2016), social comparison (Pfabigan et al., 2019), personality traits (Todorov & Uleman, 2003), social category (Freeman et al., 2012), language identity (Rafeekh & Mishra, 2020) can influence social interactions. Social interactions depend on social scripts, a pre-existing pattern of actions that an individual is expected to follow (Little, 2012). In an interactional context, this action is determined by the language identity of the interlocutor. Evidence suggests that social interactions influence executive functions and vice versa (Landry, Miller-Loncar, Smith, & Swank, 2002; Lewis & Carpendale, 2009; Moriguchi, 2014). Most of this comes from research conducted on children. Gerstadt, Hong, and Diamond (1994) compared children raised exclusively at home with

those who went to day care on the Day-Night inhibition task and found that increased social interactions led to better executive skills acquisition. Social factors have also influenced task-switching ability even in three-year-old children (Moriguchi, Lee, & Itakura, 2007). The Vygotskian approach focuses on the importance of social interaction and social learning on executive function development (Vygotsky, 1980). MacKinnon, Geiselman, and Woodward (1985) showed that the activation of lexical-semantic levels could be disabled or overridden by social and contextual factors. They explored this by testing participants on a Stroop task either individually or in pairs. In the paired condition, the participants were informed that the examiner would give extra credit to the fastest one; the other person waited outside for their turn when the participant was doing the task. The researchers observed a 25% reduction in the Stroop effect (Stroop facilitation) in the paired condition, indicating that interpersonal competition does affect performance in the Stroop task. Also, Huguet, Galvaing, Monteil, and Dumas (1999) observed that when they compared the participant performance with that of a superior co-actor, there was a significant reduction in the Stroop effect. They attribute this reduction to the temporary prevention of the spread of lexical-semantic level activation, which is thought to be involved in the Stroop paradigm's automaticity.

1.1 Social interaction and executive functions

Have you ever found yourself modifying your actions, pace of speech, or mannerisms to impress the person sitting next to you? For instance, during an interview or a date? If so, your social interactions were influenced by the presence of other people. Instances like these occur very often in our daily life. For social interactions to occur, the individual should "make sense of others' behaviour," and the set of cognitive processes involved are termed social cognition. Social cognition enables individuals to perceive and interpret social information such as facial

expressions and emotions, sustain interactions, make culturally appropriate responses, and assimilate and accommodate one's interlocutors (Arioli, Crespi, & Canessa, 2018). The majority of research on the relationship between social cognition and executive functions has been carried out in children (Landry et al., 2002; Lindsey & Malinda, 2003). Interestingly, studies have shown that bilingual children have superior social cognitive abilities and greater sociolinguistic awareness than their monolingual peers (Farhadian et al., 2010; Schroeder, 2018).

Social interaction is one of the most multifaceted human ability – it relies heavily on the communication between people; incorporates both verbal as well as non-verbal aspects of behaviour, integrates conscious as well as an unconscious cue, and it changes according to the context (De Jaegher, Di Paolo, & Gallagher, 2010; Hari, Henriksson, Malinen, & Parkkonen, 2015). Social interactions often entail complex higher cognitive processes, and evidence suggests that social experiences lead to the development of executive functions (Perry et al., 2019). For example, social exclusion is found to impact response inhibition (Snyder, Prichard, Schrepferman, Patrick, & Stoolmiller, 2004). It has been found that social interactions can lead to changes in cognitive flexibility and cognitive control (Peterson & Flanders, 2005; Skowron, Cipriano-Essel, Gatzke-Kopp, Teti, & Ammerman, 2014). Moriguchi et al. (2007) investigated the effects of social context on children's inhibitory control using the Dimensional Change Card Sorting task. The experiment was conducted in three phases – a pre-test phase in which the participants familiarised themselves with the cards to be sorted, an observation phase where an interlocutor sorted the cards, and finally, the sorting phase, where the participants were asked to sort the cards. Four experiments were carried out depending on the observation phase and the interlocutor's interactions with the participants. They found that the participants' performance was modulated by the presence of

interlocutors and the social context. Researchers work on identifying the processes that promote successful social interactions and factors contributing to them.

The sociocultural theory points out the importance of language on cognitive development and its role in social interactions, especially in bilinguals (Vygotsky, 1980). For example, bilingual children learn to depend on contextual cues during interactions to talk appropriately with conversation partners and show higher metalinguistic awareness than monolinguals (Goetz, 2003; Liu, Wellman, Tardif, & Sabbagh, 2008). Social interactions are heavily dependent on language use, and language development relies heavily on social context and interactions. Bilinguals' social interactions are benefited by the rich interactional contexts in which they live in. The next part of focuses on bilingualism and its contribution to cognitive processing. It is also essential to understand the context in which language acquisition and learning take place since they also contribute to cognitive development and processing (section 1.3).

1.2 Bilingualism and executive functions

“Being a bilingual” is a social and individual phenomenon (Wei, 2006); and can influence an individual's social, cultural, and psychological aspects. For bilinguals, social interactions take place in diverse environments with diverse interlocutors. Therefore, the ability to identify the interlocutor's language choice and accommodate and adapt to the demands of the interlocutor is a central feature of bilingualism in a social environment. The extent of language activated in different situations affects the processes involved during language control (Green, 2011) since bilinguals select language based on a particular situation and avoid interfering with the irrelevant language. Cognitive control is often described in terms of interference suppression/inhibition and switching abilities of individuals. An important aspect of cognitive control is the anticipation of upcoming information or stimulus. Through practice, individuals develop expertise in predicting

the appropriate response even during uncertainties. For example, a bilingual might anticipate upcoming words in a sentence better than a monolingual (Foucart, Martin, Moreno, & Costa, 2014; Mishra, Singh, Pandey, & Huettig, 2012). Researchers are interested in finding out how bilinguals use one language without any interference from the other language and what control mechanisms are involved in the language selection (Bialystok, Craik, Green, & Gollan, 2009; Yu & Schwieter, 2018). Is this mechanism associated with a particular language domain, or is it domain-general in nature, extending to non-linguistic tasks used to measure executive control? The following section will investigate the link between bilingualism and cognitive processing in general.

Bilinguals have the continuous demand to regulate their language use according to the environment. They activate both languages despite situations where only one language is required (Dijkstra, 2005; Marian & Spivey, 2003; Thierry & Wu, 2007). Thus, the use of two languages requires constant monitoring of the environment, restricting a language over another and shifting between languages, and so, bilingualism is associated with an enhancement in these components (Allport & Wylie, 1999; Meuter & Allport, 1999). Researchers have identified a link between the language control and cognitive control domains, i.e., a cross-talk between linguistic and non-linguistic domains. Neural networks associated with both language and cognitive control are deeply imbricated, and language selection in bilinguals can lead to improvements in the non-linguistic domain, tapped using tasks measuring executive functions (Bonfieni, Branigan, Pickering, & Sorace, 2019a). According to Green (1998), monitoring and resolution of conflicts that arise due to the activation of two languages are carried out by the general-purpose inhibitory mechanism. As a result, studies comparing monolinguals and bilinguals have found that the latter outperforms the former in tasks that measure cognitive processing, mainly executive functions

(Bialystok et al., 2009; Bialystok, Klein, Craik, & Viswanathan, 2004; Prior & Macwhinney, 2010).

Seminal work on the link between bilingualism and cognitive control has been carried out by Bialystok and her lab (Anderson, Mak, Keyvani Chahi, & Bialystok, 2018; Bialystok, 2015, 2017). Since bilinguals constantly need to exercise more than one language, demands on the cognitive control system are high. Though monolinguals face cognitive demands in terms of lexical, syntactic, and referential ambiguities (Arnold, Eisenband, Brown-Schmidt, & Trueswell, 2000; Duffy, Kambe, & Rayner, 2004; Folk & Morris, 2003), bilinguals also face this in addition to cross-language ambiguity. Evidence suggests that when bilinguals access one language, information in the other language is also accessed (Blumenfeld & Marian, 2013; Pivneva, Mercier, & Titone, 2014). Bilinguals manage the activation of languages to anticipate the upcoming linguistic demands to avoid errors. This regulation is carried out through inhibition of unwanted or the non-target language (Green, 1998; Philipp & Koch, 2009), higher activation of required response (Costa, Santesteban, & Ivanova, 2006), or better monitoring ability (Costa, Hernández, & Sebastián-Gallés, 2008), which explains the beneficial effects of bilingualism on cognition (Bialystok et al., 2009). However, this language control is different for bilinguals with differing proficiencies; high-proficient bilinguals employ language-specific selection, whereas low-proficient bilinguals rely heavily on inhibitory control (Costa et al., 2006).

Evidence shows that bilinguals outdo monolinguals on tasks measuring cognitive processing, including the Flanker task (Costa, Hernandez, Costa-Faidella, & Sebastian-Galles, 2009; Grundy, Chung-Fat-Yim, Friesen, Mak, & Bialystok, 2017), switching task (Prior & Macwhinney, 2010), Stroop task (Bialystok, Craik, & Luk, 2008), inhibition-of-return task (Colzato et al., 2008). Furthermore, factors such as proficiency in the second language (Rafeekh,

Krishna, Kapiley, & Mishra, 2021; Singh & Mishra, 2012, 2013; Tse & Altarriba, 2012), age at which the second language is acquired (Pelham & Abrams, 2013; Tao, Marzecová, Taft, Asanowicz, & Wodniecka, 2011), the extent of active bilingualism (de Bruin, Bak, & Della Sala, 2015) and other factors like social structure and education can influence cognitive processing (Cox et al., 2016). The "bilingual executive processing advantage (BEPA) hypothesis" suggests that bilingualism enhances executive processing in general, that is, a domain-general advantage rather than an inhibitory control advantage (Hilchey & Klein, 2011). Evidence for the same comes from studies showing processing benefit on tasks that do not call for conflict resolution. For example, Emmorey, Luk, Pyers, and Bialystok (2008) administered the Flanker task to three groups of participants (bilinguals, bimodal bilinguals, and monolinguals) after controlling their education level, age, verbal reasoning, and socio-economic status. They found that bilinguals had better performance irrespective of the trial type than the other groups showing indications for the "bilingual executive processing advantage" hypothesis.

The type of cognitive processing benefit that bilinguals have over monolinguals is hard to explain due to the inconsistencies in the literature. Paap and Greenberg (2013) carried out an extensive comparison between monolinguals and bilinguals. In three studies, they compared participants' performance on tasks – Simon, Flanker, antisaccade, colour-shape switching task, and Raven's Advanced Matrices – measuring executive processing. However, no confirmations supporting bilingual advantage was obtained. Similarly, researchers have failed to observe a positive impact of second language acquisition on cognitive processing. Ramos, Fernández García, Antón, Casaponsa, and Duñabeitia (2017) provided second language training (Basque) for older monolinguals for eight months and compared their performance with a group that did not receive any training to see the cognitive advantages of learning a second language. The two groups of

participants were compared on the non-linguistic colour-shape switching task before and following the training. They found that training did not influence the executive function components. However, the study conducted by Rafeekh et al. (2021) shows mixed results – they found that second language training can influence cognitive processing to some extent.

Having said this, the bilingualism research and the idea of enhanced cognitive control for bilinguals over monolinguals is viewed with much contention; researchers compare groups that have been poorly matched, and the studies often fail to replicate the existing results. Studies suggest that this results from various aspects such as the age of acquisition of a language, years of formal education in a particular language, exposure, the use and experience of language, etc. However, others have argued that this difference or superiority on tasks measuring cognitive control disappears when factors such as general cognitive ability or intelligence, education, etc., are considered. Hence, understanding the influence of bilingualism on cognitive control mechanisms is very important. Studies focus on particular aspects of being bilingual, such as proficiency, simultaneous use of language, early vs late bilingual, etc., and conduct their research. It is often impossible to consider and control all the variables simultaneously; hence, studies limit their scope to certain variables. Due to these reasons, researchers obtain different results using the same task across the various bilingual population.

Paap, Johnson, and Sawi (2015) suggest that bilingual advantage observed on non-linguistic control tasks can be associated with specific language use and experience. These critical experiences should also be taken into account. The inconsistencies in bilingualism and cognitive processing literature, especially executive functions, have motivated researchers to focus more on bilingual experience-related factors.

1.3 Bilingual language experience and control

Though bilinguals activate both the languages in parallel, the relative degree of language activation in bilinguals is dynamic and dependent on their linguistic environment¹ (Green & Abutalebi, 2013). Many researchers have studied the influence of different types of linguistic environments. For example, according to Weinreich (1966), a bilingual has to limit interferences of other languages based on the interlocutor. If the interlocutor is monolingual, then the bilinguals have to limit interference. In contrast, if the interlocutor is bilingual, they can use both languages freely, thus leading to few limits on interference. Hasselmo (1970) introduced the "modes of speaking" in bilinguals depending on the environmental context and language switching nature. Depending on the social and linguistic factors, bilinguals have to choose a language and activate that particular language. In this context, Grosjean (1985, 2013) introduced the concept of language mode "*Language mode is the state of activation of the bilingual's languages and language-processing mechanisms at a given point in time.*" He argues that bilinguals deactivate a particular language in a monolingual speech mode. In contrast, in a bilingual speech mode, they keep one language as the "base language" and activate the other language, especially during code-switching instances. This activation depends on both individual and environmental factors (Yu & Schwieter, 2018). Thus, bilinguals choose their languages differently from monolinguals and bilinguals, indicating they have to continuously keep a "tab" on their environment and switch from one language to the other based on the demands of the context and the language choice of their interlocutor.

¹Linguistic environment and interactional context have been used interchangeably in the thesis

Bilinguals' linguistic experience can affect cognitive processing and neural structures owing to the heightened demands on both language systems and the linguistic control system (Anderson, Chung-Fat-Yim, Bellana, Luk, & Bialystok, 2018; DeLuca, Rothman, Bialystok, & Pliatsikas, 2019, 2020). The diversity in linguistic experience can be mediated by various elements such as the age of acquisition (AoA), language use and exposure, second language proficiency, language dominance, the extent of language switching, etc. Bonfieni, Branigan, Pickering, and Sorace (2019b) investigated the mediatory role of linguistic experience-related factors – AoA and language exposure – on bilingual language control. They divided 83 Italian-Sardinian bilinguals into two groups based on second language proficiency, and the two groups were tested on a cued linguistic switching task. They found that increased second language exposure was associated with smaller mixing costs in both languages. Second language proficiency, as well as the age of acquisition, also modulated the performance of the participants. The cross-talk between language control and executive control is influenced by the dynamic interaction between various bilingual linguistic experience-related factors. Indications for the impact of experience-related factors on cognitive functions also comes from immersion studies. For example, Bialystok and Barac (2012) showed that immersive bilingual experience influences non-linguistic executive control tasks in a study conducted on 180 bilingual children. They also found that the duration of the bilingual experience is also associated with task performance.

The ACH explains how environmental stimuli are linked to the selection and control of languages in bilinguals. At this juncture, it is important to discuss the adaptive control hypothesis put forward by Green and Abutalebi (2013) as they try to explain how different communicative contexts – an instance of bilingual language experience – modulate the language control processes.

1.3.1 Adaptive control hypothesis (ACH). The adaptive control hypothesis connects the role of interactional context in modulating the neural and cognitive processes. The hypothesis discerns three types of interactional context depending on bilinguals' language use: (a) a single-language context – only one language is used in a context (for example, using Malayalam at home and English at school), there is hardly any switching between the languages; (b) a dual-language context – the two languages used by the bilingual co-occur in a context, but with different interlocutors (using both Malayalam and English at the workplace); and (c) a dense code-switching context – bilinguals often use both the languages during a sentence. For example, a Malayalam-English bilingual might use "Enik *car repair* cheyan kodukkanam"; *I have to give the car for repair* (Green & Abutalebi, 2013).

The ACH argues that the relative demands applied by the diverse contexts modulate the cognitive control processes and, therefore, contribute to advantages in the executive functions. It should be noted that both the languages co-occur in the dual-language and dense code-switching contexts, but switching between the languages occurs only in the dense code-switching context. Table 1 provides a picture of how different control processes are engaged as a function of the three linguistic environments.

Table 1

The relation between linguistic environment and control processes based on the ACH

Control processes	Linguistic environment		
	Single-language	Dual-language	Dense code-switching
Goal maintenance	✓	✓	–

Conflict monitoring	✓	✓	–
Interference suppression	✓	✓	–
Salient cue detection	–	✓	–
Selective response inhibition	–	✓	–
Task disengagement	–	✓	–
Task engagement	–	✓	–
Opportunistic planning	–	–	✓

Note. ✓ indicates demand on control process; – indicates no demand. (Green & Abutalebi, 2013, p. 519).

A single-language context calls for the use of only one language at any instance, and hence the demands on the control processes are less. Conflict monitoring – monitoring the context for selecting appropriate language, interference suppression – withholding unwanted language, and maintaining goal – using only one language, are demanded. In a dense-code switching context, control processes' involvement is low as the speaker is free to switch between the languages. Hence, suppression of neither one of the languages is not necessary. The speaker often engages in opportunistic planning to achieve the goals of the conversation.

The adaptive control hypothesis places special emphasis on the dual-language context since it calls for higher linguistic and cognitive control. Since specific interlocutors call for specific language activation, the bilingual speaker must be in a constant state of goal maintenance. It requires appropriate monitoring of the linguistic environment and the suppression of non-target

language at a particular instance. To account for the possibility of multiple interlocutors interacting simultaneously, the speaker must detect the salient cues present in the context and engage in selective response inhibition to meet the conversational demands. Finally, engagement and disengagement control processes come in handy when switching between the languages within the context. As a result, dual-language contexts are assumed to promote better cognitive processing.

1.4 Cross talk between interactional context and control

The last decade has seen a heightened interest in the contribution of linguistic and cultural context on language selection and cognitive control processes; especially how control processes are reliant on interactional context and interlocutor identity (Beatty-Martinez et al., 2019; Blanco-Elorrieta & Pykkänen, 2017; Hartanto & Yang, 2016, 2020; Jiao, Grundy, Liu, & Chen, 2020; Kapiley & Mishra, 2019; Ooi, Goh, Sorace, & Bak, 2018; Rafeekh & Mishra, 2020; Woumans et al., 2015; Yang, Hartanto, & Yang, 2016b).

The adaptive control hypothesis posits that diverse language experiences influence the verbal and non-verbal control processes differently (Green & Abutalebi, 2013). The regulation of these (control processes) will be reflected in those tasks that call for similar control processes. Drawing on the adaptive control hypothesis, the current thesis aims at understanding the role of bilinguals' linguistic experience on the executive control mechanism. Only a few studies have looked directly at interactional contexts' specific role in language and cognitive control. And these studies can be categorized into two:

1. effects of interactional context on bilingual language control with a focus on language comprehension and production
2. effects of interactional context on executive functions, especially executive control

Such studies have used cues such as interlocutors, cultural images, etc., words in both L1 and L2 to induce interactional context within the experiment or even comparing participants from linguistically different contexts. The following sections will look into these two categories of studies in detail.

1.4.1 Interactional Context and bilingual language control. The extent of language experience and the nature of the linguistic environment determines the extent of language control imposed on the speaker (Green, 2011). A handful of entries have shown that interlocutor's social and linguistic identity can affect how people respond to them. This section will specifically look into studies that explore how context influences language activation, comprehension, and lexical decision making.

Molnar et al. (2015) investigated whether bilinguals associated themselves with the interlocutors' identity, which affected language activation. Following the familiarization with interlocutors – monolingual and bilinguals who used Spanish, Basque, or both – the participants completed a lexical decision task. The results demonstrated that high proficient bilinguals form associations with the context, and these associations can bias language production. In another study, Martin, Molnar, and Carreiras (2016) showed that interlocutors influence brain activity – measured in ERP – even before speech. According to their study, people rely on interlocutor identity as a cue for predicting linguistic information.

In another study, Woumans et al. (2015) investigated if interlocutors' faces can influence linguistic production in two groups of bilinguals. Participants were presented with Skype conversations with interlocutors and thus familiarised with them and the language associated with them. In a language production task, they found that participants performed better when the language of the interlocutor matched the language used during the familiarisation phase; however,

when the interlocutors provided unreliable information (a mismatch between the language used by the interlocutor during the task and the language used during familiarisation phase), the effect of the facial cue on language production disappeared. The study indicates the role of top-down processing of contextual cues and that bilinguals associate a particular language with a certain interlocutor.

1.4.2 Interactional Context and executive control. Bilingual language control systems adapt depending on the linguistic context (Timmer, Christoffels, & Costa, 2018). But what about the domain-general executive system? Will the constant demand the environment exerts on bilingual speakers make them better users of inhibitory control mechanisms? Wu and Thierry (2013) investigated how the communicative context of bilinguals affects executive functioning in Welsh-English bilinguals using a simple Flanker task. Participants (mean age = 20.4 years) performed the Flanker task in three language contexts – Welsh, English, or mixed language (half Welsh and half English). The language contexts were introduced by showing task-irrelevant words before the presentation of flanker arrows. For example, in the Welsh context, welsh words were presented for 1500 ms following the fixation cross. The participants were asked to ignore these words. Both behavioural and electrophysiological recordings were taken. The results indicated an enhanced conflict resolution in the language context where both languages were present. The reactive control mechanism activated due to the mixed language context improved the executive system, which reflected on the task performance. They also found neural evidence for an "online interaction" between areas associated with language processing and domain-general executive functions. It is the first study to directly establish a link between interactional context and executive control mechanism.

Hartanto and Yang (2016) investigated the impact of bilinguals' interactional context on cognitive flexibility. Based on the language switching frequency, participants were categorized into two groups – bilinguals within single-language and dual-language context; and completed a non-linguistic colour-shape switching task. The results showed that dual-language context bilinguals had smaller switch cost indicating better task-switching ability. In another study, Hartanto and Yang (2020) investigated the link between interactional context and executive functions. Participants were categorized into three groups – single-language context, dual-language context, and dense code-switching context – based on the language use and exposure. They found that participants in dense code-switching contexts had better inhibitory control than participants in the other group; the dual-language context was connected with better cognitive flexibility. The study throws light on the importance of the role of interactional context on bilingual advantage. Different interactional contexts impose different control on the language control system, which influences the cognitive control system. Experimental evidence suggests that this influence can be observed on non-linguistic control tasks. The studies conducted in this thesis rely on this very idea.

1.5 The neuroscience of social cognition

How the neural structures deal with social contexts and what brain areas are involved is the main concern of researchers investigating the neural correlates of social cognition (Adolphs, 2010). Different brain areas are involved in the processing of stimuli with different valencies. For example, the processing of social stimuli and non-social stimuli can cause different activation levels in the fusiform and occipitotemporal gyri (Downing, Jiang, Shuman, & Kanwisher, 2001; Kanwisher, McDermott, & Chun, 1997). Amygdala is involved in processing facial expression and emotional processing and has been found to bias social cognition (Phelps et al., 2000).

Similarly, movement and interaction of objects in the environment involve activation of the inferior frontal gyrus, posterior temporal gyri, and inferior parietal lobe (Caspers, Zilles, Laird, & Eickhoff, 2010; Grèzes & Decety, 2000). The extent of bilingual experience and language use has been found to recruit the inferior frontal gyrus, anterior cingulate cortex, and inferior parietal lobe (DeLuca et al., 2020).

Ibañez and Manes (2012) investigated how contextual cues are integrated during the social situation and proposed a cortical network that involves frontal, insular, and temporal cortices. According to this social context network model (see Figure 1), the frontal brain areas are responsible for updating and generating contextual information according to episodic memory. The insular regions incorporate external and internal cues and provide an emotional aspect to the event, whereas the temporal areas integrate information from both regions. The three cortical regions are involved in the interpretation of social contexts.

Baez, García, and Ibañez (2018) point out that "*...The frontal areas adjust and update what you think, feel, and do depending on present and past happenings. These areas also predict possible events in your surroundings. The insula combines signals from within and outside your body to produce a specific feeling. The temporal regions associate objects and persons with the current situation. So, all the parts of the social context network model work together to combine contextual information when you are in social settings...*".

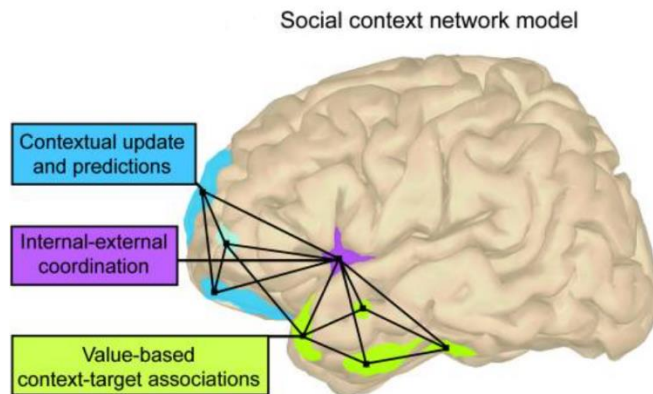


Figure 1. The social context network model proposed by Ibáñez and Manes (2012)

Understanding the role of these social networks is important as it helps explain various psychiatric and neurological conditions that have a severe effect on social cognition. The involvement of social context network in such disorders have been established by Baez, García, and Ibáñez (2016)(Baez et al., 2016). For example, the main characteristic feature of Autism Spectrum Disorder is the inability to communicate socially, which is often associated with a lack of contextual sensitivity (Klin, 2000). Schizophrenia and bipolar mood disorders are also associated with social cognition impairments (Baez et al., 2013). Though it is important to understand how neural networks communicate with each other in different interactional contexts, it is outside the scope of the current work.

1.6 Motivation

The inconsistencies in the literature on bilingualism and executive functions (EFs) have motivated researchers to focus more on the bilingual experience-related factors. Since the linguistic systems in bilinguals constantly compete for selection at varying levels, it is assumed that bilingual experiences enhance executive functions, especially cognitive control. Bilinguals are alert and sensitive to the environmental cues that aid them to pick and speak the appropriate

language. For instance, Li, Yang, Suzanne Scherf, and Li (2013) showed that non-linguistic cues influenced bilingual language processing. Chinese-English bilinguals named objects in either Chinese or English in the presence of Chinese and Caucasian faces. The presentation of these cultural cues (faces) was blocked. They showed that the cues facilitated language production when there was a congruence between face and naming language, indicating that contextual cues can influence lexical access. Hartsuiker (2015) demonstrates that linguistic cues and non-linguistic visual cues present in a context can influence language production in bilinguals. Understanding social cognition and the involvement of cognitive systems in social interaction can vary depending on the study's variables. Since language is an inevitable aspect of social interactions and the mere presence of interlocutors seems to influence neural and cognitive structures, the present work emphasizes the importance of linguistic experience on executive function.

The use of more than one language in India is not uncommon since there are 22 scheduled languages in the country. People acquire their first language – their mother tongue – at their home. The majority of the population acquire English as their second language – which is taught at schools. People often acquire other languages through social contact and media. Due to the existing education practices, students acquire English early on or at a later stage – around the age of ten in schools where the medium of instruction is L1. This can create two groups of bilinguals – those who are highly proficient in English and those who are low proficient in English. Existing evidence suggests that this variation in L2 proficiency can contribute to differences in domain-general executive control abilities (Mishra et al., 2012; Singh & Mishra, 2014). Also, the bilinguals often find themselves in an L1 dominant context. The practice of more than one language is observed due to travel, migration, academics, etc. Hence, bilinguals often rely on either Hindi or English to interact with each other. The degree of lexical activation and the demands imposed on the cognitive

control systems can vary depending on the geographical location and the languages used in the setting. By what means bilinguals acclimatise to the linguistic demands of the context and what cognitive processes are involved remains unexplored. This dissertation explores the influence of interactional context on the general cognitive control processes using non-linguistic executive function tasks in Malayalam-English bilinguals drawing on the adaptive control hypothesis.

Figure 2 demonstrates the attempt to theorize the influence of interactional contexts on cognitive control mechanisms and provides the foundation for all the experiments carried out in the thesis. It shows situations in which bilingual speakers encounter other bilinguals and the possible cognitive control mechanisms that help them adapt to the situation. A high-L2 proficient bilingual interacting with a similar interlocutor (situation A) calls for activation of L1 and L2. Since the interlocutor is free to select any language, the bilingual speaker must monitor the context and switch appropriately. In situation B, since the high-L2 proficient bilingual speaker is interacting with a low-L2 proficient interlocutor, the L2 is rarely used, and the activation of L2 will be inhibited. Whether the speaker engages in proactive or reactive inhibition will depend on other contextual factors. When a low-L2 proficient bilingual speaker interacts with a high-L2 proficient interlocutor, the former may switch while trying to adapt to the interlocutor. Whereas when a low-proficient bilingual interacts with a low-L2 proficient interlocutor, there is inhibition of L2.

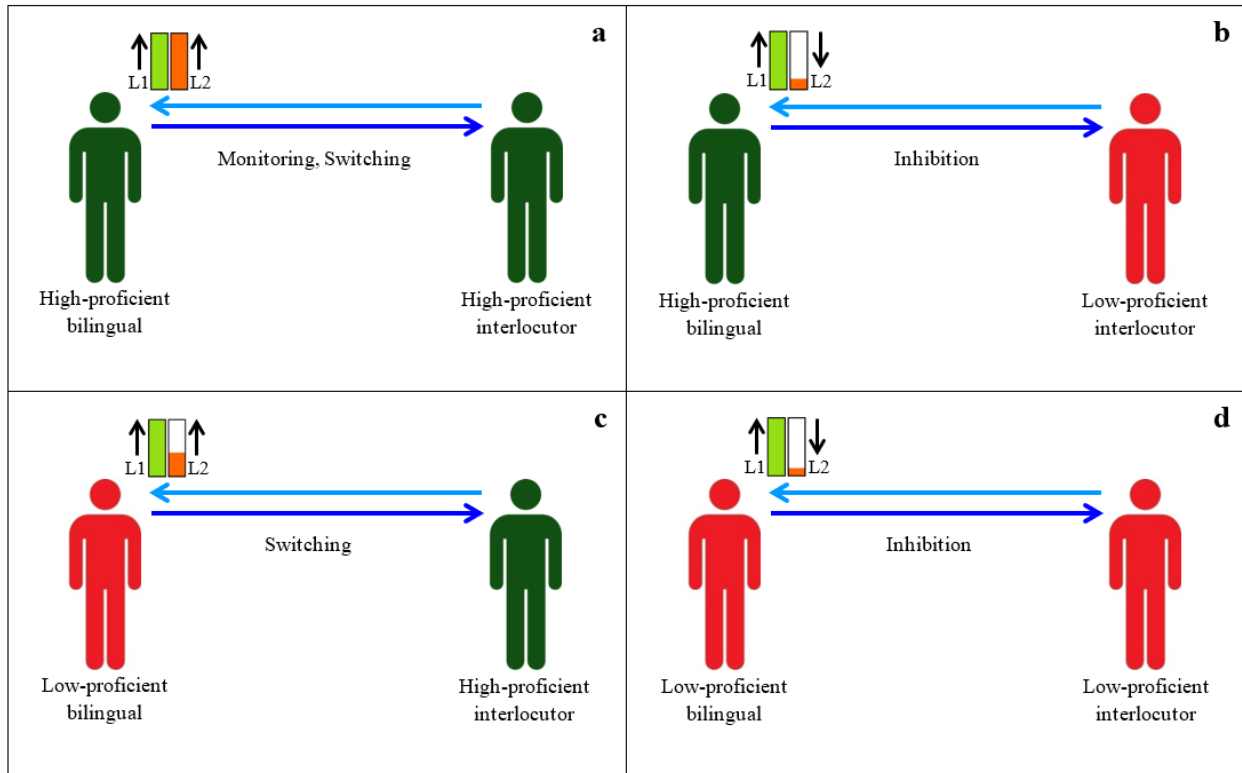


Figure 2. Possible interactive situations encountered by a bilingual and the cognitive processes involved.

The thesis aims to examine those conditions under which domain-general executive control is influenced by the interactional context and attempts to link these effects to the difference in bilingual experience. Interactional context is created by presenting cartoons (called 'interlocutors' throughout this thesis) with differing second language proficiencies. Three types of interlocutors were presented – high-L2 proficient, low-L2 proficient, and neutral interlocutor (more details on Chapter 2). Existing studies have suggested that visual cues can activate lexical representations and cognitive processing systems (Hartsuiker, 2015; Jin, Yue, Zhang, & Li, 2017; Zhang, Morris, Cheng, & Yap, 2013). Given this, it is reasonable to assume that the interlocutors presented will modulate both linguistic and non-linguistic control settings in the participants.

1.7 Objectives

While studies have investigated how interactional context modulates language production and comprehension, only a handful of entries have looked at the link between executive functions and how interactional contexts modulate the same (Gullifer & Titone, 2019; Wu & Thierry, 2013). Such studies explore this either by considering bilinguals with different bilingual experience – in terms of their geographical location or language use (Beatty-Martinez et al., 2019; Kałamała, Szewczyk, Chuderski, Senderecka, & Wodniecka, 2020; Ooi et al., 2018) or by manipulating interactional context within an experiment (Bhandari, Prasad, & Mishra, 2020; Wu & Thierry, 2013). The experiments carried out in the thesis employ both approaches to identify and understand the relationship between the two.

This work investigates the effects of interactional context on executive control in Malayalam-English bilinguals and sees how adaptation to different contexts varies with different levels of second language exposure and proficiency level. Understanding this can help explain bilingualism, especially the bilingual advantage debate since recent studies have focused on the importance of language context.

The specific objectives of the experiments carried out in this thesis include:

1. To find the relationship between executive control mechanism and interactional contexts
2. To investigate the modulatory effect of interactional context on executive control under various conflict monitoring situations manipulated by task demands
3. To explore how adaptation to different interactional contexts occur over some time and what factors contribute to the adaptation

4. To see if bilinguals associate certain language to specific interlocutors and so see if the language identity of the interlocutor influences the oculomotor control
5. To investigate the socio-psycho-linguistic factors that contribute to adaptation and bilingual advantage in general.

1.8 Overview of the Chapters

Chapter 1 provides a brief overview of social context and its influence on executive functions. Background to the existing literature on the mediatory role of bilingualism on executive functions and the role of interactional context and its influence on bilingual language control is also discussed.

Chapter 2 includes a study examining the influence of interactional context on non-linguistic executive control via the Flanker task. The study was administered on Malayalam-English bilinguals and looked at the role of second language proficiency on interlocutor adaptation. It also explores how the adaptation to different contexts varies as a function of different conflict monitoring situations created by changing task difficulty. It was hypothesized that the high-L2 proficient interlocutor calls for higher conflict monitoring in comparison to the low-L2 proficient interlocutor. In line with the existing results, high-L2 proficient bilinguals were thought to have faster response time than low-L2 proficient bilinguals when monitoring demands are high (Costa et al., 2009). Chapter 3 extends the relationship between interactional context and executive control in the oculomotor domain using the oculomotor Stroop task. The extent of influence of merely presented interlocutors on saccade latencies was of interest.

Chapter 4 examines the influence of language exposure and use and its influence on interlocutor adaptation by comparing bilinguals from different geographic locations. In this study,

two groups of participants were selected – one from the University of Hyderabad and the other from the University of Kerala. They were compared on the Flanker task at two-time points to see the changes in interlocutor adaptation and its contributing factors.

Finally, Chapter 5 summarises the findings from all three chapters and discusses them according to the existing theories. An attempt is made to identify the factors contributing to bilingual advantage and thus contribute to the long-standing debate and provide the limitations and future direction in this research area.

Chapter 2: The sensitivity to context modulates executive control: Evidence from Malayalam-English bilinguals²

Abstract

In two experiments, the study current study examined how bilinguals of differing L2 proficiency adapt to contextual factors such as interlocutor's proficiency and whether conflict monitoring plays a role in this adaptation process. Malayalam-English bilinguals were introduced with interlocutors of varying second language proficiency through an interactive session. Participants completed a Flanker task with interlocutors incorporated in it such that their performance in the presence of high-L2 proficient, low-L2 proficient and neutral interlocutors was measured. The two experiments differed in terms of monitoring conditions induced in the task by manipulating the trial numbers. The results suggest that the presence of high-proficient interlocutors modulates the conflict monitoring system and that too differently in participants of different proficiency. High-L2 proficient bilinguals entertained less conflict in the presence of high-L2 proficient interlocutors in both the experiments. The findings shed light on how contextual factors modulate the executive function and how the proficiency of the individual is important in the adaptation process.

² Rafeekh, R., & Mishra, R. K. (2020). The sensitivity to context modulates executive control: Evidence from Malayalam-English bilinguals. *Bilingualism: Language and Cognition*, 24(2), 1-16; <https://doi.org/10.1017/S1366728920000528>

2.1 Introduction

The human brain is capable of developing a model of the environment and formulating appropriate and adaptive behaviour from it (Picard & Friston, 2014). In certain instances, these habitual behaviours might not be appropriate, and so, people exert cognitive control, which is based on the cues they get from the environment. Language use in an intelligent manner requires cognitive flexibility to adapt to dynamically changing context. For a bilingual speaker, this context could be the variety of interlocutors that he/she may deal with on an everyday basis. Some interlocutors may be proficient in both languages, thus offering little problem, while others may pose challenges. This comes down to the exercise of control in language selection in the environment and is contingent on the context's changing requirements. Therefore, bilinguals must modulate their control mechanism to monitor and adapt to environmental requirements. The adaptive control hypothesis (Green & Abutalebi, 2013) considers these predictions and explains how bilinguals adjust executive control regarding changing demands of language selection in different social-communicative situations.

The language choice of the interlocutor, situations or specific contexts, prior experiences, and cultural factors (Bhatia, Prasad, Sake, & Mishra, 2017; Ellison & Miceli, 2017; Martin et al., 2016) can influence language selection. While studies have shown that bilingual speakers tag specific languages with their interlocutors (Hartsuiker & Declerck, 2009; Kapiley & Mishra, 2019; Molnar et al., 2015) and select those languages often (Liu, Timmer, Jiao, Yuan, & Wang, 2019), it is not known if this adjustment involves critical resources of executive control. In this study, it was tested whether bilinguals dynamically regulate or adjust their cognitive control (Diamond, 2013) settings for selection of appropriate with regard to the different interlocutors and even contexts, and these changes were expected in a non-linguistic task measuring cognitive control.

The works focusing on the importance of bilinguals' language experience and context are gaining popularity since they provide a better picture of the cognitive consequences of bilingualism; such studies also help in understanding the bilingual advantage debate (Beatty-Martínez & Dussias, 2017; Bialystok, 2017; Blanco-Elorrieta & Pylkkänen, 2018; Deluca, Rothman, & Pliatsikas, 2019; Yang, Hartanto, & Yang, 2016a; Yang et al., 2016b). However, only a handful of entries have looked at the direct impact of interactional context on cognitive control; they use an experimental setup to simulate various interactional contexts and use cognitive control tasks to measure the impact of context (Jiao et al., 2020, 2018; Wu & Thierry, 2013). As discussed in the introduction (section 1.4, Cross talk between interactional context and control, pg.29), these studies can be categorized into two – studies examining the influence of context on (a) language comprehension and production and (b) cognitive control.

Kapiley and Mishra (2019) recently reported that bilingual speakers keep track of their interlocutors' language proficiency and use this knowledge in later language selection. For example, in that study, high L2 proficient Telugu-English bilinguals selected English more significant number of times when they saw a cartoon that had been introduced earlier was perceived as highly proficient in English. Interestingly, these bilinguals selected Telugu (L1) a higher number of times, inhibiting their dominant English responses when they perceived the cartoon not to be good in English. This data was acquired in the context of a voluntary naming task and choices therein. This result extended the many previous findings which have shown that speakers associate specific languages to particular speakers (Hartsuiker & Declerck, 2009; Molnar et al., 2015) and use that knowledge for lexical retrieval (Martin et al., 2016). That is, in an ever-changing dynamic bi-multilingual context where speakers and interlocutors of different proficiencies encounter one another, speakers remember the languages that the interlocutors use

and evaluate their relative proficiency. This dynamic adaptation in everyday language choice indicates extreme adaptiveness of the bilingual mind and probably a significant foundation of our shared social cognition. However, the data from Kapiley and Mishra (2018) did not say what types of control mechanism the participants might be using in their adaptation strategy. Since many dominant theories have invoked executive control behind language selection in bilinguals (Green, 1998; Green & Abutalebi, 2013), it is likely that such a timely adaptive mechanism also is an outcome of such resources. However, even if we assume that one or another mechanism (inhibition, monitoring, etc. see Miyake et al., 2000) are involved in the adaptation and adjustment - including language selection - during dynamic interaction with different interlocutors, it will still be difficult to pinpoint the exact mechanism for certain specific interlocutors. For example, the type of control mechanism that a high L2 speaker requires to adjust language selection to a similar high L2 interlocutor is different from what he may require for an interlocutor with a low L2 speaker. Further, in any communicative environment, the speaker may also face both types of interlocutors. Therefore, speakers may bring in a certain type of control mechanism for specific interlocutors, which keeps changing dynamically (Mishra, 2018). Below, some studies that have addressed these issues using different paradigms are reviewed.

Hartsuiker (2015) investigated how language is associated with famous individuals by measuring language intrusions in Dutch-English-French trilinguals and found that language intrusions were more when the trials were incongruent (Dutch and English movie stars coming together) and also when they had to utter the sentences in English than in Dutch. Woumans et al. (2015) examined how visual cues modulate language production and found that faces modulate language selection and production. In another study, Liu et al. (2019) tried to see how faces associated with certain cultures impact language control by measuring reversed language

dominance effect and switch cost using a language-switching task. They found that cost associated with language switch varied across contexts, whereas no difference was observed in reversed dominant effect, which led them to conclude that contextual cues modulate the local but not global language control. However, these studies do not show the type of control mechanism behind this language tagging with interlocutors. Another set of studies have attempted to directly examine using non-linguistic attention tasks the kind of control settings bilinguals bring in depending on the language requirements of the interlocutors. For understanding the modulatory role of interactional context on task-switching performance, Hartanto and Yang (2016) categorized 133 bilinguals from the University of Singapore into two groups based on a composite score – DLC bilinguals (Dual-language context) and SLC bilinguals (single-language context). They administered colour-shape switching tasks and control measures such as the Kaufman Brief Intelligence Test (KBIT – 2), Shipley Vocabulary test, and a language background questionnaire. Both the groups differed significantly on both inter-sentential (how often the participants switched languages between sentences) and intra-sentential (how often the words from two languages were mixed) code-switching, which was treated as variables related to DLC and SLC bilingualism. In the study, they observed smaller switch costs for DLC bilinguals. They also found that inter-sentential switching negatively correlated with switching cost, whereas intra-sentential switching was a positive predictor. The study tried to show the importance of interactional context and language switching patterns on cognitive control. In another study, Ooi et al. (2018) compared participants from Edinburgh and Singapore on ANT task and the Test of Everyday Attention Elevator task to see the effects of interactional context (measured in terms of language switching behaviour and self-reports) on attentional control. For the same, they categorized the participants into four different groups – Edinburgh monolinguals (ML), Edinburgh non-switching late

bilinguals (ELB), Edinburgh non-switching early bilinguals (EEB), and Singapore switching early bilinguals (SB). They observed that the SB group had enhanced attentional control, indicating that bilinguals who engage in language switching (either dual language/dense code-switching context) were efficient in resolving conflicts. These studies show that interactional context, personal preference, and experience impacted executive control differently.

2.1.1 Current study. When a situation is demanding, people need to monitor their environment for appropriate behaviours. According to Green (1998), monitoring and resolving conflicts that arise as a consequence of the arousal of two languages are carried out by the general-purpose inhibitory control mechanism. Also, the Adaptive Control Hypothesis postulates that the language control processes acclimatize based on the linguistic context. Thus, to regulate their language use, bilinguals need to be attentive to the environmental cues (Green & Abutalebi, 2013). Importantly, Coderre, Smith, Van Heuven, and Horwitz (2016) showed an interdependent connection between the linguistic system and cognitive control in bilinguals.

The conflict monitoring system is involved in detecting changes in task demands, and it signals adjustments in behaviour through the recruitment of control processes (Teubner-Rhodes, Bolger, & Novick, 2017). Ellison and Miceli (2017) argue that monitoring also acts as a filter in addition to acting as a language-identification device. They argue that when two languages are activated, but the interlocutor speaks only one language, then the monitoring system blocks the non-target language production. The amount of monitoring is determined by the importance given by the speaker to avoid cross-linguistic intrusions. Thus, according to them, monitoring is a mechanism by which social pressures are implemented.

The context-induced monitoring demand hypothesis that is tested here is also related to India's bilingualism situation. Considering the circumstances of Indian universities, most of the

student population is either bilingual or multilingual. Importantly, depending on their number of years of schooling and English training, speakers develop different proficiencies in English.

Two different bilinguals may have similar proficiency in their first language (any Indian language) but very different English proficiency. Many studies have shown that second language proficiency of this sort influences executive control in the long run (Singh & Mishra, 2016; N. Singh & Mishra, 2012, 2013, 2014). Bilinguals switch to different languages based on the demands exerted by the interactional context, and as a result, different kinds of control mechanisms may set in (Green & Abutalebi, 2013). These interactional contexts might encompass a single or dual-language setting or a setting where there is a random shifting between the languages. The presence of different types of interlocutors in the environment can lead to different monitoring demands.

In these experiments, the idea that Indian bilinguals keep track of their interlocutors' second language proficiency to modulate their language (Kapiley & Mishra, 2019) and that this will be reflected in the control processes was exploited. That is, the present study explored if the conflict monitoring abilities of Malayalam (L1)-English (L2) bilinguals were influenced by the relative L2 proficiency of interlocutors and their language use. The aim was to see how bilinguals adapt to different interlocutors (with differing L2) using three types of cartoons – high-proficient interlocutors (who used Malayalam and English 50% of the time), low-proficient interlocutors (who used Malayalam 90% of the time and English 10% of the time) and neutral interlocutors whose language identity was not known. The interlocutors were introduced to the participants through a training session before the main experiment. If the control processes involved in adapting to different kinds of interlocutors are different, this may generalize to the non-linguistic domain, leading to a difference in the executive control measures.

It was expected that a high-L2 proficient interlocutor brings in more monitoring demands as the possibility of him/her speaking both L1 and L2 is equal, thus bringing more demands on the conflict monitoring system. So, a lower conflict effect was expected in the presence of a high-L2 proficient interlocutor compared to a low-L2 proficient interlocutor. It was also assumed that participants might have a lower conflict effect in the presence of a neutral interlocutor than a low-L2 proficient interlocutor as the former's language identity is unknown, which will impose more monitoring demands. These patterns of results were anticipated for high-L2 proficient rather than low-L2 proficient bilinguals.

How different monitoring conditions within the task regulated interlocutor adaptation was examined through a second experiment. In this case, it was assumed that the high-L2 proficient bilinguals incur a lower conflict effect in the high monitoring condition compared to the low-L2 proficient bilinguals. A reduced conflict effect in the presence of high-L2 proficient interlocutor as opposed to neutral and low-L2 proficient interlocutor was also anticipated.

2.2 Method

2.2.1 Participants. The study constituted sixty native Malayalam (L1) speakers – who acquired English (L2) at childhood (mean age of 6.08 years, $SD = 2.67$) – selected from the University of Hyderabad. Participation in the study was voluntary, and the participants provided informed consent. The study was conducted with the approval of the Institutional Ethics Committee (IEC). To assess the participants' language proficiency, both semantic fluency task and object naming task were administered in Malayalam (L1) and English (L2). They were also asked to complete the WordORnot task to evaluate their L2 proficiency and a language background questionnaire.

Following this, a composite score for English was calculated by combining the scores obtained on these four tasks, and the participants were then classified as high-L2 proficient (mean age = 22.7 years, $SD = 2.60$) and low-L2 proficient (mean age = 23 years, $SD = 3.64$) bilinguals (see Table 2). For calculating the composite score, the z-score of the tasks (semantic fluency score on English, WordORnot, self-rated proficiency in English, and naming latency in English obtained from the object naming task) were added and was divided by the square root of the sum of variances and covariances (McMurray, Samelson, Lee, & Bruce Tomblin, 2010; Mishra, Padmanabhuni, Bhandari, Viswambharan, & Prasad, 2018).

Table 2

Participant characteristics and language measures (Experiment 1)

	High-L2 proficient bilinguals (n = 30)	Low-L2 proficient bilinguals (n = 30)
	Mean (SD)	Mean (SD)
Age	22.70 (2.60)	23.00 (3.64)
Age of Acquisition		
Malayalam (L1)	1.33 (1.07)	1.51 (1.27)
English (L2) **	5.13 (2.06)	7.03 (2.47)
Years of formal education		
Malayalam**	2.67 (3.88)	6.17 (4.48)
English**	14.80 (4.05)	10.83 (4.16)
Percentage of exposure		
Malayalam	45.90 (20.44)	51.80 (16.53)

English*	46.87 (21.81)	37.67 (12.47)
Self-reported proficiency		
Malayalam	8.83 (1.34)	8.94 (0.87)
English**	8.51 (8.51)	7.21 (0.78)
Naming latency (in ms)		
Malayalam*	1178.43 (181.94)	1288.64 (166.28)
English**	1063.45 (156.99)	1208.25 (138.59)
Semantic fluency score		
Malayalam	13.57 (2.58)	12.41 (2.54)
English**	14.55 (2.21)	11.10 (2.37)
Percentage of language exposure		
Malayalam	45.90 (20.44)	51.8 (16.53)
English*	46.86 (21.81)	37.66 (12.47)
WordORnot**	58.17 (10.47)	46.37 (9.91)
Frequency of language switching		
Current	5.20 (1.71)	4.80 (1.60)
Preferred	3.38 (1.80)	3.33 (1.86)

Note. ** denotes $p < .01$, * denotes $p < .05$

2.2.2 Control measures. The details of the control measures are described in detail below.

2.2.2.1 Semantic fluency task. The semantic fluency task is used as a test of the verbal functioning of individuals. The task is typically carried out as follows, and the participants are asked to verbally name as many words as possible within a category in sixty seconds. For the

current experiment, semantic categories – animals, birds, fruits, and vegetables were used. The task was conducted in both Malayalam and English. Each language's semantic score was calculated by averaging the scores obtained in each category for that language. The scores obtained on the semantic fluency task reflect the participants' retrieval strategies and inhibition and selection of appropriate responses. The score obtained by the high-L2 proficient bilinguals ($M = 14.55$, $SD = 2.21$) was significantly better than the score obtained by low-L2 proficient bilinguals ($M = 11.10$, $SD = 2.37$) on English, $t(58) = 5.81$, $p < .001$. However, the semantic fluency scores were similar on Malayalam for high-L2 ($M = 13.57$, $SD = 2.58$) and low-L2 proficient ($M = 12.41$, $SD = 2.54$) bilinguals, $t(58) = 1.75$, $p = .08$.

2.2.2.2 WordORnot. WordORnot is an online vocabulary test developed by the Centre for Reading Research at Ghent University. It is aimed at measuring the English proficiency of the participants. The participants are asked to indicate whether a string of letters is existing English words or not by responding “yes” or “no”. A total of 100 words/non-words were presented to the participants. If the participants respond "yes" to a non-word, they are penalized. The final score is the percentage of the difference between correct responses and incorrect responses. The average score obtained by the high-L2 proficient bilinguals ($M = 58.17\%$, $SD = 10.47$) on the task was better than the low-L2 proficient bilinguals ($M = 46.37\%$, $SD = 9.91$), $t(58) = 4.48$, $p < .001$.

2.2.2.3 Language Questionnaire. A language questionnaire was administered to the participants which contained a detailed description of their language background. It included questions pertaining to language acquisition, exposure to each language, language switching frequency, and preference given to each language on different domains such as reading, writing, etc. The questionnaire also collected the self-rated proficiency in English and Malayalam on a scale of one to ten (one being the lowest score). The percentage of exposure to English was more

for the high-L2 proficient bilinguals ($M = 63.27\%$, $SD = 11.02$) compared to the low-L2 proficient bilinguals ($M = 36.83\%$, $SD = 11.74$), $t(58) = 8.99$, $p < .001$. However, the percentage of exposure to Malayalam was higher for low-L2 proficient ($M = 52.63\%$, $SD = 16.29$) compared to high-L2 proficient ($M = 28.50\%$, $SD = 9.83$) bilinguals, $t(58) = -6.94$, $p < .001$. The self-rated proficiency score in English was higher for high-L2 proficient ($M = 8.51$, $SD = 0.67$) compared to low-L2 proficient ($M = 7.21$, $SD = 0.78$) bilinguals, $t(58) = 6.92$, $p < .001$. However, the high-L2 proficient ($M = 8.83$, $SD = 1.34$) and low-L2 proficient ($M = 8.94$, $SD = 0.87$) bilinguals' self-rated proficiency in Malayalam did not differ, $t(58) = -0.36$, $p = .71$.

2.2.2.4 Object naming. The object naming task was administered in Malayalam and English to assess the participants' language proficiency objectively. Before designing the experiment, 120 black and white images of objects from the Snodgrass and Vanderwart (1980) repository and google images were selected (google images were used for incorporating more culturally significant and familiar objects/items). The selected images were rated for familiarity, frequency of use of the objects in daily life, and name agreement by 11 Malayalam-English bilinguals selected from the University of Hyderabad. The rating was carried out in both Malayalam and English. They were asked to denote a number from one to five (five-point Likert scale), with one denoting the lowest score and five the highest for each rating condition. The average ratings for each image were calculated, and 60 images with a score of 3.5 or above were selected for the task.

The experiment was conducted on the DMDX software (Forster & Forster, 2003) on a 15.6" hp laptop; the screen resolution was 1920 x 1080 with a refresh rate of 60 Hz. Before administering the object naming task, the participants were presented with 60 images for familiarisation purposes. Each trial started with a plus sign presented at the centre of the screen for

1000 ms. This was followed by a coloured square in red/green for 2000 ms. For half of the participants, the red square (language cue) represented English, and for the rest of the participants, it represented Malayalam. A picture followed the coloured square, and the participants were instructed to name the object based on the language cue verbally. The picture disappeared immediately when the participants' response triggered a voice key or after 3000 ms. A total of 120 trials, with 60 trials representing English and 60 representing Malayalam, constituted the task. The participants' responses were recorded using the Audacity software (version 2.0.5), and the experimenter manually coded the responses and errors.

The naming latencies of the participants on both the languages were calculated by removing trials (a) with latencies below 150 ms and above 3000 ms (4.36%), (b) trials in which the participants did not respond (0.75%), and (c) trials in which the participants made an error (5.50%). The naming latency in English was smaller for high-L2 proficient bilinguals ($M = 1063.45$ ms, $SD = 156.99$) compared to low-L2 proficient bilinguals ($M = 1208.25$ ms, $SD = 138.59$), $t(58) = -3.78$, $p < .001$. Interestingly, the high-L2 proficient bilinguals ($M = 1178.43$ ms, $SD = 181.94$) had smaller naming latency in Malayalam in contrast to the low-L2 proficient bilinguals ($M = 1288.64$ ms, $SD = 166.28$), $t(58) = -2.44$, $p = .01$.

2.2.2.5 Composite score. As mentioned before, the composite score was calculated to measure the L2 proficiency of the participants and to divide them into two – high-L2 proficient and low-L2 proficient – based on the aggregate score. The scores obtained by the participants on semantic fluency task (English), WordORnot, self-rated proficiency in English, and the naming latencies in English were considered for calculating the composite score. First, the mean and standard deviation for each measure was calculated. Following this, the z-score on each measure was calculated for each participant. The z-scores on the measures were then added; variance and

covariance for each measure were determined, and the sum of variance and covariance was calculated. Finally, the sum of z scores of all proficiency measures was divided with the square root of the sum of variance and covariance to obtain the composite score. A median split was done on the composite score, and participants who had higher scores were categorized as high-L2 proficient bilinguals. The composite score of high-L2 proficient bilinguals ($M = 0.01$, $SD = 0.007$) was higher than the low-L2 proficient bilinguals ($M = -0.01$, $SD = 0.11$), $t(58) = 10.58$, $p < .001$.

2.2.3 Stimuli for the experiment. The experiment constituted interlocutors of three categories – high-L2 proficient, low-L2 proficient, and neutral interlocutor. A graphic designer prepared six cartoon images (three categories of interlocutors, male and female) to represent each interlocutor. Both male and female versions of the interlocutors were used to avoid bias of any kind. A video clip of short duration was prepared to introduce the interlocutors' language identity. For this, speech samples of about 90 seconds duration were gathered from eight Malayalam-English bilinguals (the audio samples were collected from four males and four females). These bilinguals were asked to talk about climate change, health, nutrition, environmental pollution, globalization, education system, global warming, etc. For high-L2 proficient interlocutors, they were asked to use Malayalam for half of the time and English for the remaining; inter-sentential switching between the languages was also ensured. In the audio sample for the low-L2 proficient interlocutor, the bilinguals were asked to use Malayalam 90% of the time and English for 10%. Following this, eleven Malayalam-English speakers were asked to rate the speech samples on a ten-point scale on factors like the speaker's perceived proficiency, fluency, and cohesiveness. Four samples (two males, two females) were selected based on these ratings. The perceived proficiency in Malayalam did not differ between the high-L2 proficient ($M = 8.18$, $SD = 0.40$) and low-L2 proficient ($M = 8.22$, $SD = 0.34$) interlocutors, $t(20) = -0.28$, $p = .77$. The perceived proficiency in

English differed between the speech samples selected for high-L2 proficient ($M = 8.36$, $SD = 0.32$) and low-L2 proficient ($M = 8.00$, $SD = 0.00$) interlocutors, $t(20) = 33.73$, $p = .001$.

To create the video clips for interlocutors, the graphic designer first prepared short video clips in which the cartoons made lip movements and eye blinks. Following this, the audio file was superimposed to this video clip, and the lip movements were synchronized to match the audio. The video clips for each interlocutor lasted for 90-100 seconds. No video clips were made for the two neutral interlocutors since the language identity of the same remained unknown to the participants.

2.2.4 Procedure. The overall experiment was divided into four phases – (a) familiarisation phase, (b) an interaction phase wherein the participants interacted with the interlocutor by answering some of the questions asked by them, (c) the Flanker task (main experiment and control experiment) and (d) the re-familiarisation phase.

2.2.4.1 Familiarisation phase. The purpose of the familiarisation phase was to introduce the participants to interlocutors of varying proficiencies. Short video clips of high-L2 proficient and low-L2 proficient bilinguals (which lasted about 90-100 seconds) were shown to the participants.

2.2.4.2 Interaction phase. The second phase involved participants interacting with the interlocutors. Each interlocutor asked around ten questions in either Malayalam or English and the participants had to respond. The high-L2 proficient interlocutors asked half of the questions in Malayalam and the rest in English (five questions in each language in random order). Two questions asked by the low-L2 proficient interlocutor were in English and the remaining in Malayalam. The participants were free to choose the comfortable language while responding to each interlocutor; their responses were recorded using Audacity software and an iBall microphone. The participants were also asked to assess the perceived language proficiency and language use

pattern of each interlocutor. They correctly identified the approximate percentage of language use of each interlocutor.

2.2.4.3 Flanker task. The Flanker task constituted two parts – the main experiment in which the interlocutors were present and the control experiment. In the control experiment, trials started with a plus sign at the centre of the screen and stayed for 500 ms. Following this, the Flanker arrows were displayed at the centre of the screen for around 1700 ms. The Flanker arrows were of two types – congruent ($\rightarrow\rightarrow\rightarrow\rightarrow\rightarrow$ or $\leftarrow\leftarrow\leftarrow\leftarrow\leftarrow$) and incongruent ($\rightarrow\rightarrow\leftarrow\rightarrow\rightarrow$ or $\leftarrow\leftarrow\rightarrow\leftarrow\leftarrow$); on congruent trials; all the arrows pointed toward the same direction whereas, on the incongruent trials, the central arrow pointed towards the opposite direction. The presentation of the congruent and incongruent trials throughout the experiment was random. The participants were instructed to perform the task by pressing the appropriate key corresponding to the direction of the central arrow; they were asked to press "A" on the keyboard if the central arrow pointed towards the left side of the screen and "L" if the central arrow pointed towards the right. Subsequently, a blank screen was presented for 1000 ms, which was considered the inter-trial interval. The participants completed 24 practice trials (12 trials each on congruent and incongruent conditions) before proceeding to the actual experiment. A total of 160 trials were presented in the control task with 80 congruent and 80 incongruent trials. The participants were given a break after 80 trials.

The main experiment incorporated the three interlocutors (high-L2 proficient, low-L2 proficient, and neutral interlocutors) into the Flanker task (Figure 3). Before the presentation of the Flanker arrows, these interlocutors were presented for 1500 ms. The presentation of interlocutors was blocked – only one type of interlocutor appeared at a time, and the presentation of blocks was randomized. The rest of the experiment was similar to the control experiment. Each

interlocutor block had 160 trials (80 congruent and 80 incongruent), making 480 trials (three interlocutors, 160 trials each) in the main experiment. After every 80th trial, a break was provided. Twenty-four practice trials were also given to the participants. The presentation of the control experiment and the main experiment was randomized across participants.

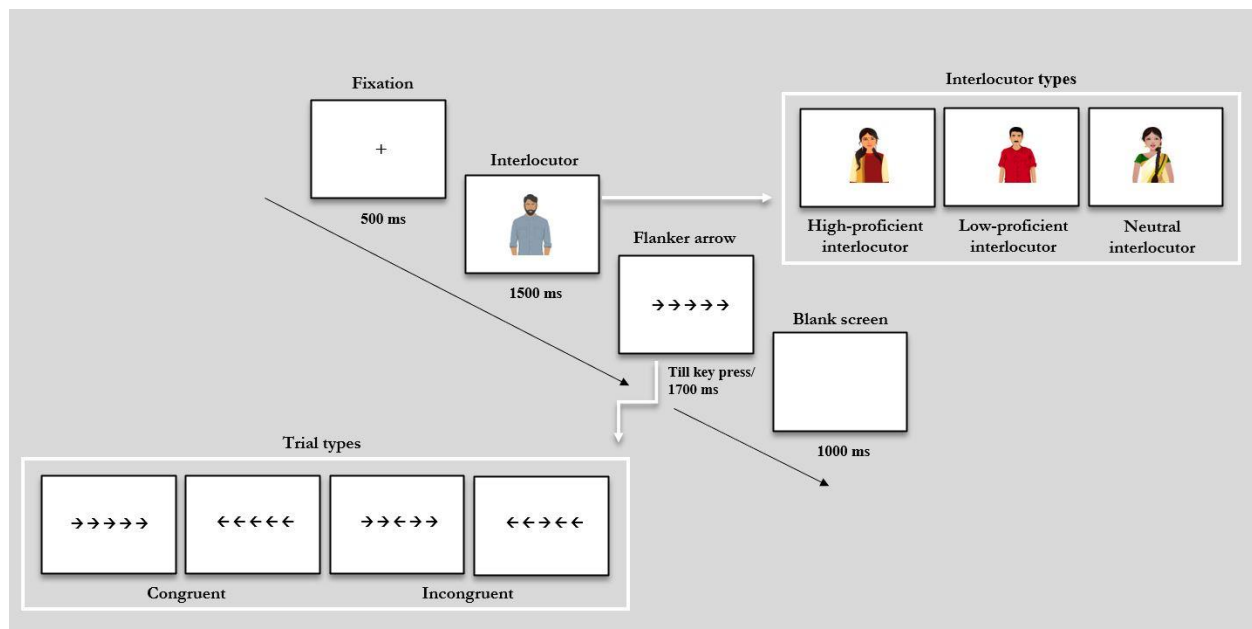


Figure 3. Schematic representation of Flanker task incorporated with three interactional contexts.

2.2.4.4 Re-familiarisation phase. As mentioned above, the presentation of different types of interlocutors was blocked. Each interlocutor block had 160 trials, and participants received a break after every 80th trial. During breaks in the high-L2 proficient and low-L2 proficient blocks, the interlocutors appeared on the screen and asked the participants three questions, and they had to respond to each question. The interlocutors were presented in this fashion to reinforce the link/association between interlocutor and their language identity. The responses given by the participants were recorded, and they selected their language based on the language used by the interlocutor.

2.3 Results

Before analysing the data, the trials with no responses were rejected (1.2%). Following this, trials above and below 2.5 standard deviations (around 4.5% of the total trials) from the average reaction time (RT) of each participant were removed as outliers. Incorrect responses (1.1%) were also removed before the analysis. Considering interlocutor (high-L2 proficient, low-L2 proficient, and neutral interlocutors) and trial type (congruent and incongruent) as within-subject factors and group (high-L2 proficient and low-L2 proficient bilinguals) as between-subject factor, repeated-measures ANOVA was carried out.

The participants were faster when they encountered high-L2 proficient interlocutors ($M = 607.12$ ms, $SE = 10.16$) compared to both low-L2 proficient interlocutors ($M = 608.43$ ms, $SE = 10.38$) and neutral interlocutors ($M = 622.34$ ms, $SE = 11.94$) (Table 3). This was indicated by a significant main effect of interlocutor, $F(2, 116) = 6.10$, $p = .003$, $\eta^2 = .09$. Since the difference between reaction times in the presence of high-L2 proficient and low-L2 proficient interlocutors seemed small, pairwise comparisons were performed. The results indicate that the difference between high-L2 proficient interlocutors and low-L2 proficient interlocutors was not significant ($p = .80$). However, the difference between high-L2 proficient interlocutors and neutral interlocutors ($p = .004$) and the difference between low-L2 proficient interlocutors and neutral interlocutors ($p = .001$) was significant. The main effect of trial type was present, participants responded faster on congruent trials ($M = 587.86$ ms, $SE = 10.15$) compared to incongruent trials ($M = 637.40$ ms, $SE = 11.00$); $F(1, 58) = 313.72$, $p < .001$, $\eta^2 = .84$. The analysis of reaction time also revealed that high-L2 proficient bilinguals ($M = 588.05$ ms, $SE = 14.84$) had faster reaction times on the Flanker task than low-L2 proficient bilinguals ($M = 637.21$ ms, $SE = 14.84$). This was also supported by a main effect of group, $F(1, 58) = 5.48$, $p = .02$, $\eta^2 = .08$.

Table 3

Mean reaction time of the participants across the experimental condition

Condition	High-L2 proficient bilinguals		Low-L2 proficient bilinguals	
	Congruent	Incongruent	Congruent	Incongruent
HP	566.36 (78.67)	600.24 (77.85)	603.48 (78.61)	658.40 (82.80)
LP	557.77 (73.88)	613.59 (80.30)	604.45 (77.98)	657.92 (93.90)
NT	568.79 (78.57)	621.53 (92.25)	626.30 (99.96)	672.73 (101.80)
Control	471.24 (63.20)	518.29 (56.25)	509.98 (72.91)	559.31 (64.09)

Note. HP: High-L2 proficient, LP: Low-L2 proficient and NT: Neutral interlocutor; C: Congruent trials, IC: Incongruent trials; standard deviation (SD) in parentheses

Further, the two-way interaction between interlocutor and trial type was significant. However, the Mauchly's test indicated that the assumption of sphericity had been violated, $\chi^2(2) = 8.81$, $p = .01$, therefore degrees of freedom were corrected using Huynh-Feldt estimate of sphericity ($\epsilon = .91$). The corrected interaction between interlocutor and trial type was also significant, $F(1.83, 106.16) = 3.98$, $p = .02$, $\eta^2 = .06$. To interpret the interaction, the difference between incongruent and congruent trials, termed conflict effect, was considered. Conflict effects was much lower in the presence of high-L2 proficient interlocutors ($M = 44.39$ ms, $SE = 2.82$) compared to low-L2 proficient ($M = 54.64$ ms, $SE = 3.94$) and neutral interlocutors ($M = 49.58$ ms, $SE = 3.62$). Pairwise comparisons showed that there is a significant difference between high-L2 proficient and low-L2 proficient interlocutors ($p = .007$), and marginal significant difference between high-L2 proficient and neutral interlocutors ($p = .08$) (Figure 4). Conflict effect between low-L2 proficient interlocutor and neutral interlocutor was not significant ($p = .23$). The two-way

interaction between interlocutor and group was not significant, $F(2, 116) = 0.45$, $p = 0.63$, $\eta^2 = .008$. Similarly, the interaction between trial type and group failed to reach significance, $F(1, 58) = 0.54$, $p = 0.46$, $\eta^2 = .009$.

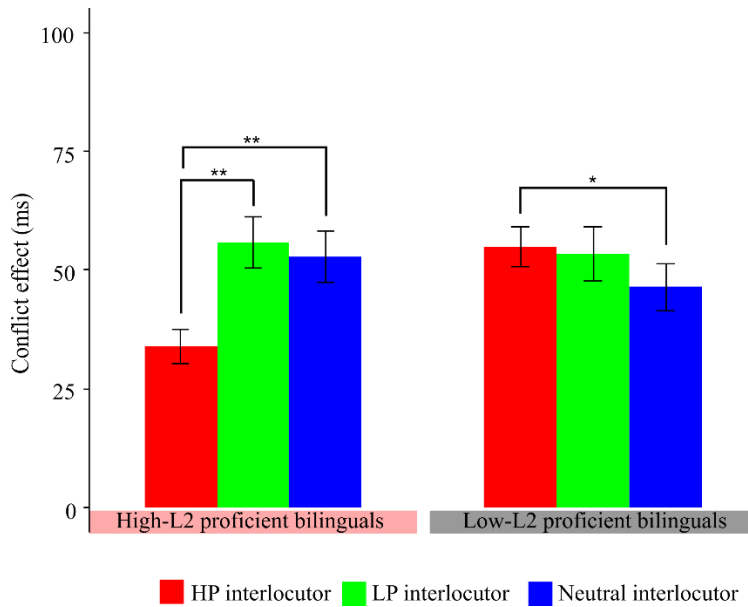


Figure 4. Conflict effect in the presence of high-L2 proficient (HP), low-L2 proficient (LP) and neutral interlocutors. (Note. Error bars represent SE)

The three-way interaction between interlocutor, trial type and group was significant, $F(2, 116) = 8.28$, $p < .001$, $\eta^2 = .12$. Similar to the interpretation of interlocutor and trial type interaction, to further interpret the three-way interaction, a two-way ANOVA was performed on the conflict effect (Costa et al., 2009; reaction time on incongruent trials – reaction time on congruent trials). The three interlocutors were considered the within-subject factor and group (high-L2 proficient and low-L2 proficient bilinguals) as the between-subject factor. The conflict effect was smaller in for high-L2 proficient bilinguals ($M = 33.87$ ms, $SE = 3.99$) compared to low-L2 proficient bilinguals ($M = 54.92$, $SE = 3.99$) in the presence of high-L2 proficient interlocutors ($p < .001$).

However, the conflict effect between high-L2 proficient and low-L2 proficient bilinguals did not differ in the presence of both low-L2 proficient ($p = .76$; high-L2 proficient bilinguals: $M = 55.82$ ms, $SE = 5.57$; low-L2 proficient bilinguals: $M = 53.46$ ms, $SE = 5.57$) and neutral interlocutors ($p = .38$; high-L2 proficient bilinguals: $M = 52.74$ ms, $SE = 5.13$; low-L2 proficient bilinguals: $M = 46.43$ ms, $SE = 5.13$).

The error analysis was carried out on the percentage of errors made with interlocutor (high-L2 proficient, low-L2 proficient and neutral interlocutors) and trial type (congruent and incongruent) as within subject factors and group (high-L2 proficient and low-L2 proficient bilinguals) as between subject factor (Table 4). The main effect of trial type was present, $F(1,58) = 62.17$, $p < .001$, $\eta^2 = .51$, with participants committing fewer errors on congruent trials ($M = 0.38\%$, $SE = 0.08$) compared to incongruent trials ($M = 2.05\%$, $SE = 0.22$). The main effects of interlocutor [$F(2,116) = 0.44$, $p = .64$, $\eta^2 = .008$] and group [$F(1,58) = 0.01$, $p = .90$, $\eta^2 < .001$] were not significant. The two-way interactions between interlocutor and group [$F(2,116) = 1.38$, $p = .25$, $\eta^2 = .02$], trial type and group [$F(1,58) = 0.38$, $p = .53$, $\eta^2 = .007$], and, interlocutor and trial type [$F(2,116) = 0.71$, $p = .49$, $\eta^2 = .01$] failed to reach significance. However, the three-way interaction between interlocutor, trial type and group was significant, $F(2,116) = 5.18$, $p = .007$, $\eta^2 = .08$.

Table 4

Mean error rates (%) of the participants across the experimental conditions

Condition	High-L2 proficient bilinguals		Low-L2 proficient bilinguals	
	Congruent	Incongruent	Congruent	Incongruent
HP	0.37 (0.87)	1.95 (1.96)	0.33 (0.72)	1.95 (2.16)

LP	0.37 (0.99)	2.58 (2.87)	0.70 (1.56)	1.58 (2.02)
NT	0.25 (0.83)	1.87 (2.09)	0.25 (0.60)	2.37 (1.77)
Control	1.00 (2.06)	3.58 (4.07)	0.37 (0.74)	2.62 (2.88)

Note. HP: High-L2 proficient, LP: Low-L2 proficient and NT: Neutral interlocutor; SD in parentheses

2.3.1 Control Experiment. Before analysing the data, missing trials were discarded (0.17%). Further, trials above and below 2.5 standard deviations from each participant's mean reaction time were removed as outliers (3.8%). Incorrect trials (1.8%) were also removed before the analysis. Like the main experiment, repeated-measures ANOVA was performed on the data obtained from the control experiment with the trial type (congruent and incongruent) as within-subject factor and group (high-L2 proficient and low-L2 proficient bilinguals) as between-subject factor.

The main effect of trial type was significant, $F(1,58) = 333.79$, $p < .001$, $\eta^2 = .85$; participants' performance on congruent trials ($M = 490.61$ ms, $SE = 8.80$) was significantly faster compared to incongruent trials ($M = 538.80$ ms, $SE = 7.78$). The main effect of group was also significant, $F(1,58) = 5.90$, $p = .01$, $\eta^2 = .09$ indicating that the performance of high-L2 proficient bilinguals ($M = 494.77$ ms, $SE = 11.60$) were faster than low-L2 proficient bilinguals ($M = 534.65$ ms, $SE = 11.60$) on the Flanker task. However, the interaction between trial type and group failed to reach significance, $F(1,58) = 0.18$, $p = .66$, $\eta^2 = .003$.

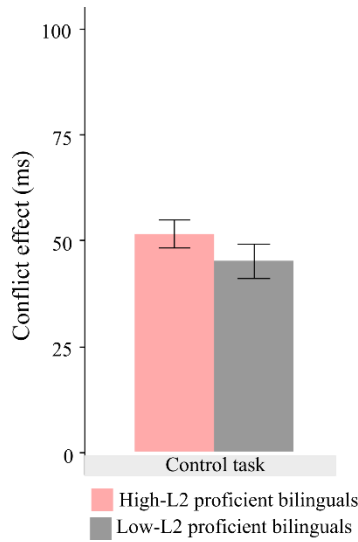


Figure 5. Conflict effect in the control condition across both groups of participants. No difference was observed between high-L2 proficient and low-L2 proficient bilinguals.

Similar to the main experiment, error analysis was carried out with trial type (congruent and incongruent) as within subject factor and group (high-L2 proficient and low-L2 proficient bilinguals) as between subject factor. The main effect of trial type was significant, $F(1,58) = 30.20$, $p < .001$, $\eta^2 = .34$; the participants committed more errors on incongruent trials ($M = 3.10\%$, $SE = 0.45$) compared to congruent trials ($M = 0.68\%$, $SE = 0.20$). The main effect of group [$F(1,58) = 0.14$, $p = .70$, $\eta^2 = .002$] as well as the interaction between trial type and group [$F(1,58) = 0.14$, $p = .70$, $\eta^2 = .002$] failed to reach significance.

2.3.2 Correlations. Correlation between the conflict effects in the presence of the three interlocutors (task performance under different experimental conditions) and different second language measures (such as composite score, years of education in English, age of acquisition of English, percentage of exposure to Malayalam and English, English naming latency, English vocabulary score, and self-rated proficiency in English) across all participants was calculated.

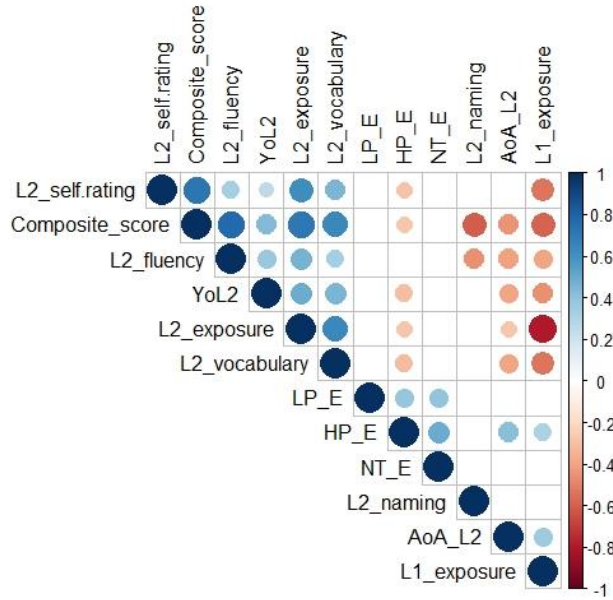


Figure 6. Correlation between conflict effect in the presence of high-L2 proficient interlocutor (HP_E), low-L2 proficient interlocutor (LP_E) and neutral interlocutor (NT_E) with different language variables (YoL2 represents years of formal education in L2, AoA_L2 represents the age of acquisition of L2).

The conflict effect in the presence of high-L2 proficient interlocutor positively correlated with age of acquisition of English ($\gamma = .41, p < .001$) and exposure to Malayalam ($\gamma = .31, p = .01$), indicating that higher exposure to Malayalam and late acquisition of English contribute to poor adaptation towards high-L2 proficient interlocutors. There was a significant negative correlation between conflict effect in the presence of high-L2 proficient interlocutor and composite score ($\gamma = -.27, p = .03$), years of education in English ($\gamma = -.30, p = .01$), exposure to English ($\gamma = -.27, p = .03$), English vocabulary score (WordORnot score; $\gamma = -.31, p = .01$), and self-rated

proficiency in English ($\gamma = -.28, p = .02$). The conflict effects in the presence of low-L2 proficient interlocutor and neutral interlocutor did not correlate with any of the language measures ($p > .05$).

2.4 Discussion

The results show that the appearance of interlocutors influenced participants' performance on the task before each trial. It was noted that the interlocutor's language profile and the participants' second language proficiency contributed to the performance on the Flanker task. The control experiment data indicates that high-L2 proficient bilinguals were faster than low-L2 proficient bilinguals. This result is consistent with the previous body of literature that has shown that bilinguals' proficiency contributes to the performance on various executive control tasks (Costa et al., 2008; Prior & Macwhinney, 2010; Singh & Mishra, 2013, 2014).

The performance of high-L2 proficient bilinguals showed evidence for adaptation across interlocutors of varying language proficiencies; the interference from the task was less in the presence of interlocutors with higher proficiency in the second language and hence lower conflict effect in such interlocutors' presence. The low-L2 proficient bilinguals did not show any evidence for adaptation (the changes in conflict effect across different interlocutors was considered as a measure of adaptation); that is, their performance did not vary in the presence of different interlocutors. The results obtained show that varying interactional contexts influence individuals' cognitive control settings, which supports the ACH proposed by Green and Abutalebi (Green & Abutalebi, 2013). Thus, the experiment provides evidence for cognitive control adaptation to meet certain interlocutors' demands/interactional contexts.

2.5 Experiment 2

Evidence suggests that when the demands imposed by a situation are high, the high-L2 proficient bilinguals tend to perform better than the low-L2 proficient bilinguals (Singh, Prasad, & Mishra, 2019; Singh & Mishra, 2013). In Experiment 1, the distribution of congruent and incongruent trials was equal, which created a high monitoring condition for the participants. Since they were unable to predict the upcoming trial, they functioned at an enhanced cognitive control setting. The high-L2 proficient bilinguals were able to tackle the task interference better than the low-L2 proficient bilinguals. It was observed that the passive appearance of interlocutors during the task could influence the task performance, especially in the case of high-L2 proficient bilinguals in the presence of high-L2 proficient interlocutors (interlocutors with similar language identity). Thus, the greater monitoring of the environment/situation brought about by the presence of demanding interlocutors helped the participants to modulate their cognitive control demands and adapt to the situation by lowering the conflict.

The second experiment tried to see if the results held true even when the task demands were low for the two groups of participants. Since low monitoring conditions have certain trial types appearing in a higher concentration, it was expected that the participants to adopt a simple strategy during task performance. Thus, the second experiment was conducted with the same task but with two monitoring conditions – high and low. A magnitude difference in the conflict effect and the interlocutor adaptation was expected even in the low monitoring condition.

2.5.1 Method.

2.5.1.1 Participants. The study consisted of eighty-eight Malayalam-English bilinguals (mean age = 23.36 years, $SD = 2.55$) from the University of Hyderabad. The participants acquired Malayalam from birth and English around 7.63 years ($SD = 2.67$). Like Experiment 1, the participants completed the semantic fluency task, WordORnot, language questionnaire, and object

naming task. The scores obtained on these tasks were used to calculate the composite score of the participants, following which they were divided into two group – high-L2 proficient ($n = 48$; $M = 22.95$ years, $SD = 2.59$) and low-L2 proficient bilinguals ($n = 40$; $M = 23.9$ years, $SD = 2.78$).

Table 5

Participant characteristics (Experiment 2)

	High-L2 proficient bilinguals ($n = 48$)	Low-L2 proficient bilinguals ($n = 40$)
Age (in years)	22.95 (2.56)	23.9 (2.78)
Age of Acquisition		
Malayalam	1.36 (0.72)	1.71 (1.04)
English**	5.13 (1.80)	7 (2.46)
Years of formal education		
Malayalam**	3.12 (4.40)	6.95 (4.27)
English*	14.10 (4.51)	10.92 (4.66)
Percentage of exposure		
Malayalam	34.91 (9.25)	51.77 (14.22)
English**	57.41 (11.17)	40.52 (12.81)
Self-reported proficiency		
Malayalam	8.75 (0.94)	8.66 (1.01)
English**	8.29 (0.86)	7.27 (0.72)

Naming latency (in ms)		
Malayalam*	1192.50 (183.04)	1321.65 (157.32)
English**	1114.20 (156.78)	1269.91
Semantic fluency score		
Malayalam**	14.31 (2.65)	11.80 (2.28)
English**	15.10 (2.34)	11.07 (2.19)
WordORnot**	58.47 (12.74)	42.55 (11.23)
Switching frequency		
Current	5.27 (1.55)	5.3 (4.02)
Preferred	3.85 (1.83)	4.02 (1.82)

Note. ** denotes $p < .01$, * denotes $p < .05$; SD in parentheses

2.5.1.2 Control measures. The scores obtained by the participants on control measures are described below.

2.5.1.2.1 Semantic fluency task. The score obtained by the high-L2 proficient bilinguals ($M = 15.10$, $SD = 2.34$) on English was significantly better than the score obtained by low-L2 proficient bilinguals ($M = 11.07$, $SD = 2.19$), $t(86) = 8.27$, $p < .001$. The semantic fluency scores obtained on Malayalam also differed between high-L2 ($M = 14.31$, $SD = 2.65$) and low-L2 proficient ($M = 11.80$, $SD = 2.28$) bilinguals, $t(86) = 4.71$, $p < .001$.

2.5.1.2.2 WordORnot. The scores obtained by the high-L2 proficient bilinguals ($M = 58.48\%$, $SD = 12.75$) on the task were higher than the low-L2 proficient bilinguals ($M = 42.55\%$, $SD = 11.23$), $t(86) = 6.15$, $p < .001$.

2.5.1.2.3 Language Questionnaire. The percentage of exposure to English was more for the high-L2 proficient bilinguals ($M = 57.42\%$, $SD = 11.29$) compared to the low-L2 proficient bilinguals ($M = 40.53\%$, $SD = 12.97$), $t(86) = 6.52$, $p < .001$. However, the percentage of exposure to Malayalam was higher for low-L2 proficient ($M = 51.78\%$, $SD = 14.40$) compared to high-L2 proficient ($M = 34.92\%$, $SD = 9.35$) bilinguals, $t(86) = -6.61$, $p < .001$. The self-rated proficiency in English was higher for high-L2 proficient ($M = 8.29$, $SD = 0.87$) compared to low-L2 proficient ($M = 7.27$, $SD = 0.76$) bilinguals, $t(86) = 5.74$, $p < .001$. However, the high-L2 proficient ($M = 8.25$, $SD = 0.64$) and low-L2 proficient ($M = 8.13$, $SD = 0.88$) bilinguals' self-rated proficiency in Malayalam did not differ, $t(86) = 0.70$, $p = .48$.

2.5.1.2.4 Object naming. The naming latencies of the participants on both the languages were calculated by removing trials (a) with latencies below 150 ms and above 3000 ms (4.16%), (b) trials in which the participants did not respond (1.25%), and (c) trials in which the participants made an error (7.20%). The naming latency in English was smaller for high-L2 proficient bilinguals ($M = 1114.22$ ms, $SD = 156.78$) compared to low-L2 proficient bilinguals ($M = 1269.91$ ms, $SD = 161.70$), $t(86) = -4.57$, $p < .001$. Interestingly, the high-L2 proficient bilinguals ($M = 1192.56$ ms, $SD = 183.04$) had smaller naming latency in Malayalam in contrast to the low-L2 proficient bilinguals ($M = 1321.65$ ms, $SD = 157.32$), $t(86) = -3.50$, $p = .001$. The pattern of results obtained was similar to Experiment 1.

2.5.1.2.5 Composite score. The composite score of high-L2 proficient bilinguals ($M = 0.01$, $SD = 0.008$) was higher than the low-L2 proficient bilinguals ($M = -0.01$, $SD = 0.008$), $t(86) = 13.50$, $p < .001$.

2.5.1.3 Procedure. Experiment 2 followed a similar procedure as Experiment 1 with an exception in the main Flanker task. Participants completed the familiarisation phase, followed by

the interaction phase. They then proceeded to do the Flanker task. In Experiment 2, the task had two monitoring conditions – high and low monitoring. The high monitoring condition constituted forty-eight congruent and forty-eight incongruent trials. Following Costa et al., 2009, the low monitoring condition was further divided into two – low monitoring 1 (92% congruent trials) and low monitoring 2 (8% congruent trials). In the low monitoring 1, eighty-eight trials were congruent, and eight trials were incongruent, whereas in the low monitoring 2 condition, only eight trials were congruent, and the rest were incongruent. The presentation of low monitoring conditions was counterbalanced.

In the main experiment, the interlocutors' presentation was blocked, and they were presented in both the high and low monitoring conditions of the task. There was a total of 576 trials with breaks at every 96th trial. The interlocutors interacted with the participants during these breaks (except neutral interlocutor; re-familiarisation phase). The control experiment had 192 trials, 96 in the high monitoring condition and the rest (96 trials) in the low monitoring condition.

2.5.2 Results

Before performing the repeated measures ANOVA, trials without any response (1.1%) were discarded. Also, those trials that were above and below 2.5 standard deviations from the mean of each participant were removed (4.4%). 1.2% of the trials were discarded as incorrect trials. Interlocutor (high-L2 proficient interlocutor, low-L2 proficient interlocutor and neutral interlocutors), monitoring condition (high monitoring and low monitoring), and trial type (congruent and incongruent) were considered as within-subject factors, and group (high-L2 proficient bilinguals and low-L2 proficient bilinguals) was considered as between-subject factor.

The degrees of freedom were corrected using Huynh-Feldt estimate of sphericity ($\epsilon = .88$), $\chi^2(2) = 14.83$, $p = .001$. The participants had faster reaction times in the presence of high-L2

proficient interlocutors ($M = 609.60$ ms, $SE = 7.47$) compared to neutral interlocutors ($M = 622.29$ ms, $SE = 7.53$); the reaction times were slowest in the presence of low-L2 proficient interlocutors ($M = 632.00$ ms, $SE = 7.31$), $F(1.77, 152.77) = 11.11$, $p < .001$, $\eta^2 = .11$ (Table 6). To see if there was significant difference between reaction time in the presence of different interlocutors, pairwise comparison was carried out. The results showed that reaction time in the presence of high-L2 proficient interlocutor was significantly faster than that in the presence of low-L2 proficient interlocutor ($p < .001$); also, there was a significant difference in the performance of the participants in the presence of high-L2 proficient and neutral interlocutors ($p = .01$) with participants responding faster in the presence of the former. The difference between low-L2 proficient and neutral interlocutors ($p = .01$) was also present; participants were slower in the presence of low-L2 proficient interlocutors. The main effect of trial type was significant, $F(1, 86) = 420.90$, $p < .001$, $\eta^2 = .83$; participants were much slower on incongruent trials ($M = 652.76$ ms, $SE = 7.48$) compared to congruent trials ($M = 589.83$ ms, $SE = 6.66$). There was a significant main effect of monitoring, $F(1, 86) = 6.40$, $p = .01$, $\eta^2 = .06$ as well as group, $F(1, 86) = 10.93$, $p = .001$, $\eta^2 = .11$. The high-L2 proficient bilinguals ($M = 598.41$ ms, $SE = 9.32$) were able to resolve the task conflicts faster compared to the low-L2 proficient bilinguals ($M = 644.18$ ms, $SE = 10.21$).

Table 6

Mean reaction time of the participants across the experimental conditions

Interlocutor Condition	Monitoring Condition	High-L2 proficient bilinguals		Low-L2 proficient bilinguals	
		Congruent	Incongruent	Congruent	Incongruent
HP	High	570.74 (76.22)	589.10 (73.63)	629.66 (89.18)	676.77 (85.85)

	Low	552.46 (63.52)	598.82 (55.20)	591.28 (79.05)	667.94 (98.51)
	High	576.40 (62.12)	643.30 (68.31)	625.38 (81.19)	673.28 (89.37)
LP	Low	557.90 (56.39)	683.74 (79.03)	622.13 (87.21)	673.85 (87.71)
	High	579.05 (64.64)	633.44 (69.02)	627.83 (80.44)	680.43 (94.58)
	Low	555.29 (63.66)	640.71 (60.41)	589.88 (80.71)	671.70 (103.47)
NT	High	506.31 (50.77)	532.60 (54.65)	525.68 (62.80)	575.23 (63.39)
Control	Low	506.21 (55.36)	569.98 (72.66)	517.36 (72.16)	594.16 (74.61)

Note. HP: High-L2 proficient, LP: Low-L2 proficient and NT: Neutral interlocutor; SD in parentheses

Mauchly's test showed that the sphericity assumption had been violated for the interaction between interlocutor and trial type, $\chi^2(2) = 6.55$, $p = .03$; $F(1.92, 165.42) = 20.82$, $p < .001$, $\eta^2 = .19$. The difference between reaction time on incongruent trials and congruent trials (conflict effect) was used to interpret this interaction. Participants had smaller conflict effect when encountering high-L2 proficient interlocutors ($M = 47.12$ ms, $SE = 3.99$) compared to neutral interlocutors ($M = 68.55$ ms, $SE = 4.03$); the conflict effect was highest in the presence of low-L2 proficient interlocutors ($M = 73.08$ ms, $SE = 3.80$). There was a significant difference between conflict effect in the presence of high-L2 proficient and neutral interlocutors ($p < .001$) as well as high-L2 proficient and low-L2 proficient interlocutors ($p < .001$). The conflict effect in the presence of neutral interlocutors did not differ with that in the presence of low-L2 proficient interlocutor ($p = .32$). The two-way interaction between interlocutor and group was also significant, $F(2, 172) = 5.54$, $p = .005$, $\eta^2 = .06$. This was further examined through pairwise comparisons. For high-L2 proficient bilinguals, the reaction time in the presence of high-L2 proficient ($M = 577.78$ ms, $SE = 10.08$) and low-L2 proficient ($M = 615.34$ ms, $SE = 9.86$)

interlocutors ($p < .001$), high-L2 proficient and neutral ($M = 602.12$, $SE = 10.16$) interlocutors ($p = .001$), and, low-L2 proficient and neutral interlocutors ($p = .01$) were significantly different. However, these differences between the interlocutors, that is, between high-L2 proficient ($M = 641.41$, $SE = 11.04$) and low-L2 proficient ($M = 648.66$, $SE = 10.81$) interlocutors ($p = .34$), high-L2 proficient and neutral ($M = 642.46$, $SE = 11.13$) interlocutors ($p = .89$), as well as, low-L2 proficient and neutral interlocutors ($p = .26$) was absent in the case of low-L2 proficient bilinguals.

An interaction between interlocutor and monitoring was observed, $F(2,172) = 5.64$, $p = 0.004$, $\eta^2 = 0.06$. The pattern of conflict effect under the three interlocutor conditions were similar across both high and low monitoring conditions. Under the high monitoring condition, conflict effect in the presence of high-L2 proficient interlocutors ($M = 32.73$ ms, $SE = 3.15$) was significantly different from low-L2 proficient ($M = 57.39$ ms, $SE = 3.58$) interlocutors ($p < .001$). Also, there was a significant difference in conflict effect in the presence of high-L2 proficient and neutral ($M = 53.49$ ms, $SE = 3.27$) interlocutors ($p < .001$); however, the difference between low-L2 proficient and neutral interlocutors ($p = .30$) failed to reach significance. In the low monitoring condition, there was a significant difference between high-L2 proficient ($M = 61.51$ ms, $SE = 6.53$) and low-L2 proficient ($M = 88.77$ ms, $SE = 6.09$) interlocutors ($p = .001$), and, high-L2 proficient and neutral ($M = 83.61$ ms, $SE = 6.07$) interlocutors ($p < .001$); the difference between low-L2 proficient and neutral interlocutors was not significant ($p = .51$). A significant two-way interaction between monitoring and trial type was also observed, $F(1,86) = 51.61$, $p < 0.001$, $\eta^2 = 0.37$. The conflict effect was reduced in the high monitoring condition ($M = 47.87$ ms, $SE = 2.39$) in contrast to the conflict effect in low monitoring condition ($M = 77.97$ ms, $SE = 4.67$). The monitoring by group interaction was also significant, $F(1,86) = 5.63$, $p = 0.02$, $\eta^2 = 0.06$. It was observed that high monitoring and low monitoring conditions differed significantly for both high-L2 and low-

L2 proficient bilinguals. The interaction between trial type and group failed to reach significance, $F(1,86) = 1.14, p = .28, \eta^2 = .01$.

The three-way interaction between interlocutor, trial type and group was significant, $F(2,172) = 39.47, p < 0.001, \eta^2 = 0.31$. For high-L2 proficient bilinguals, there was a significant difference in the conflict effect between high-L2 proficient ($M = 32.36$ ms, $SE = 5.38$) and low-L2 proficient ($M = 96.36$ ms, $SE = 5.12$) interlocutors ($p < .001$), high-L2 proficient and neutral ($M = 69.90$ ms, $SE = 5.44$) interlocutors ($p < .001$), as well as, between low-L2 proficient and neutral interlocutors ($p < .001$). For low-L2 proficient bilinguals, there was no difference between high-L2 proficient ($M = 61.88$ ms, $SE = 5.90$) and low-L2 proficient ($M = 49.81$ ms, $SE = 5.61$) interlocutors ($p = .07$), and high-L2 proficient and neutral ($M = 67.20$ ms, $SE = 5.96$) interlocutors ($p = .32$); however, there was a significant difference between low-L2 proficient and neutral interlocutors ($p = .01$). The three-way interaction between monitoring, trial type and group was also significant, $F(1,86) = 4.85, p = 0.03, \eta^2 = 0.05$. However, the interaction between interlocutor, monitoring and group [$F(2,172) = 0.13, p = .87, \eta^2 = .002$] as well as the interaction between interlocutor, monitoring and trial type [$F(2,172) = 0.05, p = .94, \eta^2 = .001$] failed to reach significance.

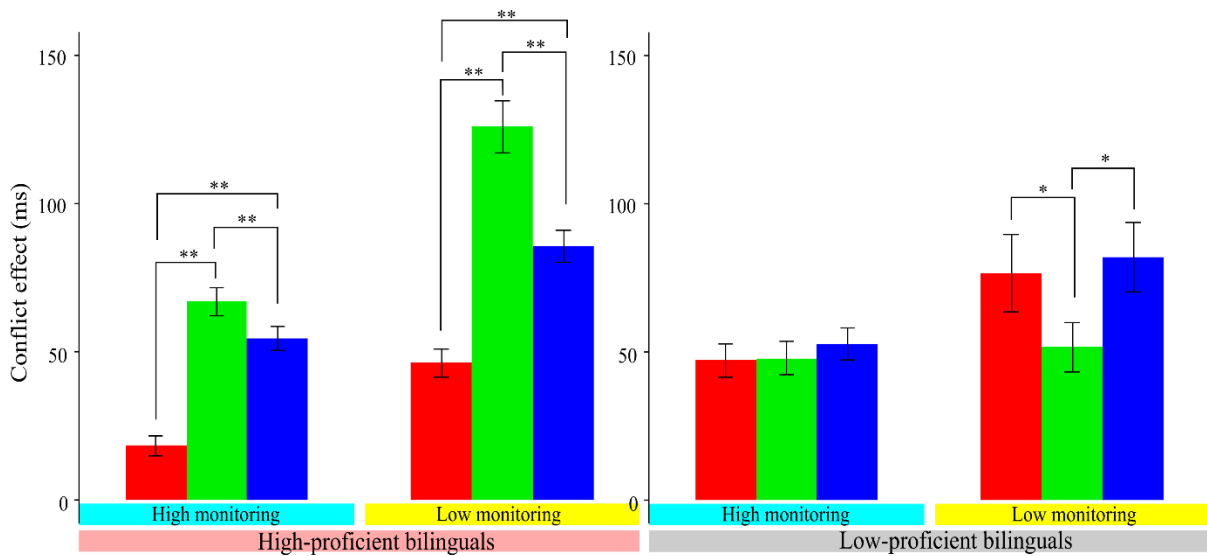


Figure 7. Conflict effect in the presence of different experimental conditions. (Note. Error bars represent SE)

Importantly, the interaction between interlocutor, monitoring, trial type and group was significant, $F(2,172) = 8.24$, $p < 0.001$, $\eta^2 = 0.08$. A thorough look at this interaction showed that for high-L2 proficient bilinguals, there was a significant difference in conflict effect between all interlocutors under both high and low monitoring conditions (Figure 7). Under the high monitoring condition, conflict effect was reduced in the presence of high-L2 proficient interlocutor ($M = 18.36$ ms, $SE = 4.25$) compared to neutral ($M = 54.39$ ms, $SE = 4.42$) and low-L2 proficient ($M = 66.89$ ms, $SE = 4.83$) interlocutors. Also, there was significant difference between high-L2 and low-L2 proficient interlocutors ($p < .001$), high-L2 proficient and neutral interlocutors ($p < .001$), and, low-L2 proficient and neutral interlocutors ($p = .01$). In the low monitoring condition, there was a significant difference between high-L2 proficient ($M = 46.36$ ms, $SE = 8.80$) and low-L2 proficient ($M = 125.84$ ms, $SE = 8.22$) interlocutors ($p < .001$), high-L2 proficient and neutral ($M = 85.41$ ms, $SE = 8.19$) interlocutors ($p < .001$), and, low-L2 proficient and neutral interlocutors ($p < .001$).

However, for low-L2 proficient bilinguals, there was no significant difference between high-L2 proficient ($M = 47.11$ ms, $SE = 4.66$) and low-L2 proficient ($M = 47.90$ ms, $SE = 5.29$) interlocutors ($p = .90$), high-L2 proficient and neutral ($M = 52.60$ ms, $SE = 4.84$) interlocutors ($p = .33$), and, low-L2 proficient and neutral interlocutors ($p = .39$) in the high monitoring condition. In the low monitoring condition, there was a significant difference between high-L2 proficient ($M = 76.66$ ms, $SE = 9.64$) and low-L2 proficient ($M = 51.71$ ms, $SE = 9.00$) interlocutors ($p = .03$), and, low-L2 proficient and neutral ($M = 81.81$ ms, $SE = 8.97$) interlocutors ($p = .01$); the difference between high-L2 proficient and neutral interlocutors ($p = .54$) was absent. The conflict effect was lowest in the presence of low-L2 proficient interlocutors (for low-L2 proficient bilinguals under low monitoring condition).

Error analysis was carried out with interlocutor (high-L2 proficient, low-L2 proficient and neutral interlocutors), monitoring (high and low), trial type (congruent and incongruent) as within subject factors and group (high-L2 proficient and low-L2 proficient bilinguals) as between subject factor on percentage of error trials. Participants made fewer errors in the high monitoring condition ($M = 1.47\%$, $SE = 0.15$) compared to low monitoring condition ($M = 2.12\%$, $SE = 0.28$) which was indicated by a main effect of monitoring, $F(1,86) = 5.10$, $p = .02$, $\eta^2 = .05$. The main effect of trial type was also significant, participants made fewer errors on congruent trials ($M = 0.41\%$, $SE = 0.06$) compared to incongruent trials ($M = 3.18\%$, $SE = 0.33$), $F(1,86) = 78.12$, $p < .001$, $\eta^2 = .47$. The main effect of interlocutor [$F(2,172) = 0.03$, $p = .97$, $\eta^2 < .001$] as well as group [$F(1,86) = 0.006$, $p = .93$, $\eta^2 < .001$] failed to reach significance.

Table 7

Mean error rates of participants in various experimental conditions

Interlocutor condition	Monitoring condition	High-L2 proficient bilinguals		Low-L2 proficient bilinguals	
		Congruent	Incongruent	Congruent	Incongruent
HP	High	0.17 (0.58)	2.86 (3.31)	0.31 (0.75)	2.18 (2.58)
	Low	0.61 (1.88)	3.69 (7.81)	0.17 (0.41)	4.26 (8.44)
LP	High	0.39 (1.10)	2.95 (3.64)	0.83 (1.62)	2.70 (4.60)
	Low	0.63 (1.93)	3.10 (6.28)	0.28 (0.76)	3.77 (6.78)
NT	High	0.43 (1.04)	2.56 (2.79)	0.46 (0.99)	1.77 (2.03)
	Low	0.42 (1.03)	3.52 (7.37)	0.17 (0.48)	4.77 (8.91)
Control	High	0.69 (1.62)	1.82 (2.49)	0.57 (1.24)	2.18 (3.01)
	Low	1.30 (3.02)	2.24 (5.10)	0.99 (2.91)	2.52 (6.58)

Note. HP: High-L2 proficient, LP: Low-L2 proficient and NT: Neutral interlocutor; SD in parentheses

In error analysis, the two-way interaction between monitoring and trial type was significant, $F(1,86) = 6.61$, $p = .01$, $\eta^2 = .07$. The errors committed on congruent trials under the high ($M = 0.4\%$, $SE = 0.06$) and low ($M = 0.38\%$, $SE = 0.08$) monitoring conditions were similar; whereas, participants made more errors in the low monitoring ($M = 3.85\%$, $SE = 0.54$) condition compared to the high monitoring ($M = 2.50\%$, $SE = 0.27$) condition on incongruent trials. The interactions between interlocutor and group [$F(2,172) = 0.08$, $p = .91$, $\eta^2 = .001$], monitoring and group [$F(1,86) = 0.53$, $p = .46$, $\eta^2 = .006$], trial type and group [$F(1,86) = 0.10$, $p = .74$, $\eta^2 = .001$], interlocutor and monitoring [$F(2,172) = 0.82$, $p = .43$, $\eta^2 = .01$], and, interlocutor and trial type

[$F(2,172) = 0.17, p = .84, \eta^2 = .002$] were not significant. Also, the three-way interaction between interlocutor, monitoring and group [$F(2,172) = 0.26, p = .77, \eta^2 = .003$], interlocutor, trial type and group [$F(2,172) = 0.02, p = .97, \eta^2 < .001$], monitoring, trial type and group [$F(1,86) = 3.32, p = .07, \eta^2 = .03$], and, interlocutor, monitoring and trial type [$F(2,172) = 0.77, p = .46, \eta^2 = .009$] were not significant. The four-way interaction between interlocutor, monitoring, trial type and group also failed to reach significance, $F(2,172) = 0.04, p = .95, \eta^2 < .001$.

2.5.2.1 Control Experiment. Before analysing the data, trials in which the participants failed to respond (0.21%), outliers (4%), and incorrect trials (1.1%) were removed. Repeated measures ANOVA with monitoring (high and low) and trial type (congruent and incongruent) as within-subject group factors and group (high-L2 proficient and low-L2 proficient bilinguals) as a between-subject factor was carried out on the reaction time data.

The participants had faster performance in the high monitoring condition ($M = 534.96$ ms, $SE = 5.94$) with respect to the low monitoring condition ($M = 546.93$ ms, $SE = 6.91$), $F(1,86) = 7.96, p = 0.006, \eta^2 = 0.08$. As expected, the reaction time on congruent trials ($M = 513.89$ ms, $SE = 6.07$) were faster than incongruent trials ($M = 567.99, SE = 6.57$), $F(1,86) = 245.62, p < 0.001, \eta^2 = 0.74$. The main effect of group was significant; the high-L2 proficient bilinguals ($M = 528.78$ ms, $SE = 8.21$) responded to the Flanker trials much quicker than the low-L2 proficient bilinguals ($M = 553.11$ ms, $SE = 8.99$), $F(1,86) = 3.98, p = 0.04, \eta^2 = 0.04$.

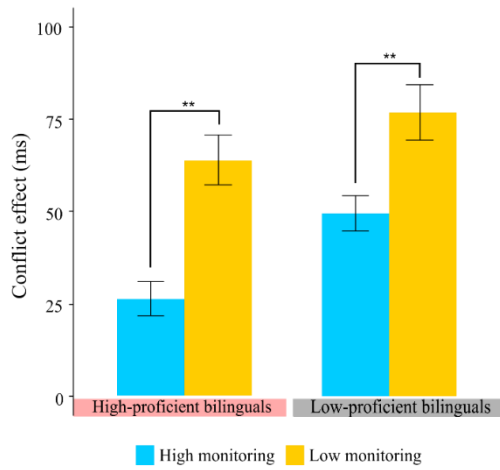


Figure 8. Conflict effect across high and low monitoring conditions for both high-L2 proficient and low-L2 proficient bilinguals. Conflict effect was lower in the high monitoring compared to the low monitoring condition.

A significant two-way interaction between monitoring and trial type was observed, $F(1,86) = 42.27$, $p < 0.001$, $\eta^2 = 0.33$. There was no difference between high ($M = 516.00$ ms, $SE = 6.05$) and low ($M = 511.78$ ms, $SE = 6.80$) monitoring conditions on congruent trials. However, there was a significant difference between reaction time on incongruent trials in both the high ($M = 553.92$ ms, $SE = 6.29$) and low ($M = 582.07$ ms, $SE = 7.87$) monitoring conditions. Also, the conflict effect was lower in the high monitoring ($M = 37.91$ ms, $SE = 3.33$) compared to the low monitoring condition ($M = 70.28$ ms, $SE = 5.00$), indicating better conflict resolution under high monitoring condition (Figure 8). The interaction between trial type and group was also significant, $F(1,86) = 6.90$, $p = 0.01$, $\eta^2 = 0.07$. The high-L2 proficient bilinguals ($M = 506.26$ ms, $SE = 8.18$) did not differ from low-L2 proficient bilinguals ($M = 521.52$ ms, $SE = 8.97$) in reaction time on congruent trials ($p = .21$). However, there was a significant difference in reaction time of high-L2 proficient bilinguals ($M = 551.29$ ms, $SE = 8.87$) with that of low-L2 proficient bilinguals

($M = 584.69$ ms, $SE = 9.71$) on incongruent trials ($p = .01$). Thus, the high-L2 proficient bilinguals ($M = 45.03$, $SE = 4.65$) had reduced conflict effect compared to low-L2 proficient bilinguals ($M = 63.17$, $SE = 5.09$) indicating better conflict resolution for the former. The two-way interaction between monitoring and group was not significant, $F(1,86) = 2.47$, $p = .11$, $\eta^2 = .02$. Also, the three-way interaction between monitoring, trial type and group was insignificant, $F(1,86) = 1.05$, $p = .30$, $\eta^2 = .01$.

Error analysis was carried out with monitoring (high and low) and trial type (congruent and incongruent) as within subject factors and group (high-L2 proficient and low-L2 proficient bilinguals) as between subject factor. The participants committed more errors on incongruent trials ($M = 2.19\%$, $SE = 0.36$) compared to congruent trials ($M = 0.89\%$, $SE = 0.21$) which was indicated by a main effect of trial type, $F(1,86) = 9.77$, $p = .002$, $\eta^2 = .10$. However, the main effect of monitoring [$F(1,86) = 1.65$, $p = .20$, $\eta^2 = .01$] as well as the main effect of group [$F(1,86) = 0.01$, $p = .90$, $\eta^2 < .001$] was absent. The two-way interactions between monitoring and group [$F(1,86) = 0.03$, $p = .84$, $\eta^2 < .0001$], trial type and group [$F(1,86) = 0.41$, $p = .52$, $\eta^2 = .005$], and, monitoring and trial type [$F(1,86) = 0.03$, $p = .85$, $\eta^2 < .001$] were not significant. Also, the three-way interaction between monitoring, trial type and group also failed to reach significance, $F(1,86) = 0.005$, $p = .94$, $\eta^2 < .001$.

2.5.2.2 Correlations. Correlation between the conflict effects in the presence of the three interlocutors (task performance under different experimental conditions) and different second language measures (composite score, years of education in English, age of acquisition of English, percentage of exposure to Malayalam and English, English naming latency, English vocabulary score, and self-rated proficiency in English) across all participants was calculated.

The conflict effect in the presence of high-L2 proficient interlocutor in the high monitoring condition correlated negatively with self-rated proficiency in English ($\gamma = -.20, p = .05$), exposure in English ($\gamma = -.25, p = .01$), semantic fluency in English ($\gamma = -.27, p = .009$), and the composite score ($\gamma = -.29, p = .005$). Similarly, in the low monitoring condition, the conflict effect in the presence of high-L2 proficient interlocutor correlated negatively with exposure in English ($\gamma = -.25, p = .01$), semantic fluency in English ($\gamma = -.36, p < .001$), and composite score ($\gamma = -.26, p = .01$). The exposure to Malayalam positively correlated with conflict effect in the presence of high-L2 proficient interlocutor in both high ($\gamma = .23, p = .02$) and low ($\gamma = .22, p = .03$) monitoring conditions.

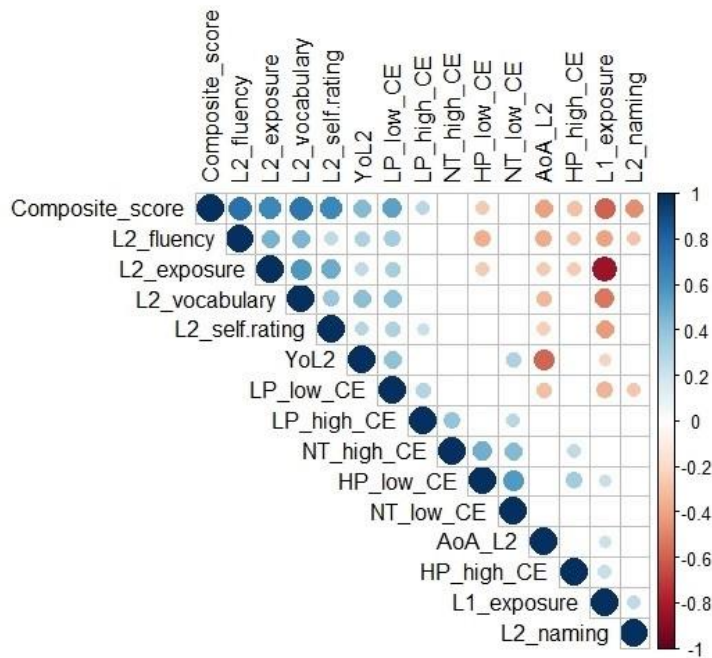


Figure 9. Correlation between different language variables and conflict effect in the interlocutor conditions.

2.5.3 Discussion. Evidence obtained from the two experiments suggests that bilinguals pay close attention to their interlocutors and later use this information to adapt to situations they encounter. The results align with the previous works showing that high-L2 proficient bilinguals have greater conflict resolution than low-L2 proficient bilinguals. Interlocutors with varying proficiencies could influence the participants, which was captured on a non-linguistic cognitive control task. The high-L2 proficient bilinguals had lesser conflict effect in the presence of high-L2 proficient interlocutors in both high and low monitoring conditions. This indicates that they are capable of adapting to their interlocutors even when the context is less demanding. However, for low-L2 proficient bilinguals, a lower conflict effect was found in the presence of low-L2 proficient interlocutors under the low monitoring condition. It is possible that low-L2 proficient bilinguals adapt to less demanding situations and when the interlocutor's identity is similar.

2.6 General discussion

The present study investigated if bilinguals are sensitive to their interlocutors of different proficiencies and if this, in turn, influences their cognitive control ability measured through a non-linguistic control task. The first experiment tried to see if interactional context influences executive functions. The second experiment was conducted to see if changing the monitoring demands within the experiment led to some changes in executive control modulation by bilinguals of different proficiencies. Malayalam-English bilinguals performed the Flanker task in different interactional contexts. The results revealed that dynamic changes in the interactional context influence executive control. The results agree with the predictions put forward by the ACH (Green & Abutalebi, 2013), showing that control processes are modulated to meet the requirements of various interactional contexts. In the current study, interactional contexts were manipulated by interlocutors of different language identities/proficiency.

It was noted that during the occurrence of high-L2 proficient interlocutor, the conflict effect measured was reduced drastically as opposed to low-L2 proficient and neutral interlocutors, and this was observed in high-L2 proficient bilinguals. The interactional context is demanding when there is a high-L2 proficient interlocutor (chances of shifting/alternating between L1 and L2 is higher), and so, the participants brought in higher monitoring and control in their presence which reflected on the reaction time (faster RT on both trial type) of the Flanker task. More importantly, the adaptation to interlocutors was seen in high-L2 proficient compared to low-L2 proficient bilinguals. The results from experiment 2 suggest that the participants were sensitive to the monitoring demands of the tasks and that high-L2 proficient bilinguals had a significantly reduced conflict effect in the presence of high-L2 proficient interlocutors in both high and low monitoring conditions of the task. These findings are in line with the idea that based on the characteristics of the interactional context, the demands on control processes vary in bilinguals (Green & Abutalebi, 2013) and that high-L2 proficient bilingual modulates the executive control in response to that. The results also suggest that when bilinguals interact with either bilinguals or monolinguals, they consider the language proficiencies, i.e., bilinguals adapt to the communication demands by considering certain aspects of the interlocutor (Green & Abutalebi, 2013; Grosjean, 2001). The data support previous findings where researchers explored interlocutors' influence and found that different interlocutors affect the behaviour differently (Li et al., 2013; Molnar et al., 2015). The presence of high-L2 proficient interlocutors made the context more demanding, and hence, the participants prepared themselves to perform better by monitoring their environment constantly and bringing in more executive control. Reduced conflict effect was observed both in the high and low monitoring condition of the task in experiment 2 in the presence of a high-L2 proficient

interlocutor (only for high-L2 proficient bilinguals), indicating that rather than the demands of the task, it was the presence of the interlocutor that influenced the performance of the participants.

Dissimilar interactional contexts place diverse challenges on language control processes, and these processes adapt depending on the demands (Green & Abutalebi, 2013). In their study, Wu and Thierry (2013) investigated the role of language context on the Flanker task in English-Welsh bilinguals. They presented English or Welsh words in between the task and directed the participants to ignore them, and the manipulation of language context was carried out through the presentation of these words. They found reduced errors for incongruent trials in the mixed block instead of the single blocks and reduced P300 amplitude (component associated with cognitive interference). They interpret the results suggesting that non-linguistic conflict resolution is facilitated by a mixed language context rather than a single language context. They note that "*since it is task-irrelevant, the incidental processing of words from two languages did not directly compete for cognitive resources with nonverbal conflict resolution. Instead, the mixed-language context shifted the executive system to an enhanced functional level, thus improving the effectiveness of nonverbal conflict resolution*".

The use of language-specific control mechanisms to inhibit non-target language is a frequently encountered situation for bilinguals, which may lead to more demands on the domain-general executive control. In the presence of high-L2 proficient interlocutors, two control processes – conflict monitoring (which monitors for conflict) and interference suppression are important, as these interlocutors can switch between both the languages (during the interaction session, they alternate between L1 and L2 frequently). The demands placed by low-L2 proficient interlocutors on the language control processes are low as the low-L2 proficient interlocutors rarely switch between the languages. In the case of neutral interlocutors, the demands on the monitoring

system are high when compared to low-L2 proficient interlocutors because the language identity of the former is not known, and they might use any of the languages, and hence the participants will have to anticipate this and monitor for the cues. These expectations that participants had (especially high-L2 proficient bilinguals) for their interlocutors were reflected in the Flanker task performance. High-L2 proficient bilinguals were faster in responding to the task in the presence of high-L2 proficient interlocutors followed by neutral interlocutors; they were the slowest in the presence of low-L2 proficient interlocutors. This is consistent with the findings that high-L2 proficient and balanced bilinguals can modulate their attention in different monitoring contexts and that they have better interference control and conflict resolution abilities (Carlson & Meltzoff, 2008; Singh & Mishra, 2012, 2013; Tao et al., 2011). Jiao et al. (2018) explored whether language control mechanisms involved in different language contexts (L1, L2, and mixed) influence executive functions and, if so, how. They administered a language comprehension task interleaved with a flanker task (experiment 1 & 2) and a non-conflict control task (experiment 3 & 4) in four Chinese-English bilingual experiments. They found that in experiments 1 & 2, in the mixed block, the participants performed faster on both congruent and incongruent trials indicating better monitoring functions, and in experiments 3 & 4, where there was no conflict, the performance on all the three contexts was similar. They conclude their study by pointing out that the monitoring mechanism functions as a bridge between the language control process and cognitive control. It is crucial to note that the presence of high-L2 proficient interlocutors brought down the reaction time on both trials compared to low-L2 proficient and neutral interlocutors, indicating that the monitoring mechanism was indeed involved.

In their study on the effect of interactional context on attentional control, Ooi et al. (2018) compared participants from Edinburgh and Singapore on ANT task and Test of Everyday Elevator

task attention by categorizing them into four different groups – Edinburgh monolinguals, Edinburgh non-switching late bilinguals, Edinburgh non-switching early bilinguals and Singapore switching early bilinguals and found that attentional control was impacted differently by different interactional contexts. They found that bilinguals who engage in language switching (based on the interactional context) were better at conflict resolution. Similarly, Hartanto and Yang (2016) divided bilinguals into two groups based on their language use – those within a single-language context and those within a dual-language context and compared them on a colour-shape switching task (non-linguistic switching task). Bilinguals within dual-language context had lesser switch costs compared to bilinguals within single-language context. Their results suggest that interactional contexts regulate executive control abilities.

The results from the control experiment in the study indicate that high-L2 proficient bilinguals were faster in responding to the Flanker arrows than low-L2 proficient bilinguals. This RT advantage aligns with previous studies, which showed an advantage for high proficient bilinguals in executive functioning (Singh & Mishra, 2012, 2013, 2014). According to Hilchey and Klein (2011), this advantage may be considered a result of superior executive networks.

The study points out that bilinguals are sensitive to their environmental context and adapt to their interlocutors by taking into consideration the relative proficiencies of the interlocutors (Mishra, 2018). Different interactional contexts have different executive control requirements, and this was reflected in the participants' performance in different blocks of the experiment (different blocks represented different interlocutors).

Chapter 3: Does interactional context modulate oculomotor control?

Abstract

Though researchers have explored the relationship between interactional context and how it influences cognitive control mechanisms, whether it holds the same in the oculomotor domain remains unclear. In this study, high-L2 proficient bilinguals performed an oculomotor version of the Stroop task adapted from Singh and Mishra (2013) in the presence of interlocutors of varying L2 proficiency. Participants were asked to look at the target object while ignoring the distractors. The performance of the participants was better in the presence of high-L2 proficient interlocutors as opposed to low-L2 proficient and neutral interlocutors. Since challenging situations modulate oculomotor control to a great extent, it is assumed that the participants' performance is influenced by the presence of an interlocutor. The evidence thus suggests the modulatory role of context on oculomotor control.

3.1 Introduction

Humans voluntarily control their eye movements and actions towards relevant stimuli to meet the demands of the current goal. In particular, this control (cognitive control) is the essence of our life as it is associated with voluntary behaviour; they help in goal-directed actions. Those stimuli that capture attention also influence eye movements (Ludwig & Gilchrist, 2002), and the allocation of attention depends on various top-down and bottom-up factors (Knudsen, 2007). Top-down factors like prior knowledge, experience, cultural context, and current goals, which are voluntarily driven as well as bottom-up factors (involuntary) like physical features of the stimuli, abrupt onset, etc. influence the attentional and oculomotor capture (Le Pelley, Beesley, & Griffiths, 2015; Le Pelley, Pearson, Griffiths, & Beesley, 2015; Pearson, Donkin, Tran, Most, & Le Pelley, 2015; Theeuwes & Belopolsky, 2012). These factors can dynamically interact with each other and influence oculomotor capture. Though salient stimuli present in the environment capture attention, people tend to override these stimulus-driven influences; people make goal-directed saccades that require cognitive control. The ability to control or modify such eye movements can be captured through tasks measuring executive functions. Tasks such as the anti-saccade task and oculomotor Stroop task and investigation of saccades come in handy while understanding cognitive control. For example, an understanding of stimulus-response association can be understood using an anti-saccade task.

3.1.1 Social context and eye movements. It is important to understand the role of social stimuli on cognitive control as social psychology research shows that the mere presence of people in the environment can enhance or hinder actions (Allport, 1924; Triplett, 1898). Much research on social attention has focused on the influence of interlocutors' gaze direction (social cues) on

attentional processes (Atkinson, Simpson, & Cole, 2018; Tricoche, Ferrand-Verdejo, Pélisson, & Meunier, 2020).

Faces of other people can capture and retain attention to a great extent compared to other social stimuli. Salvia, Harvey, Nazarian, and Grosbras (2020) investigated the activity of brain areas involved in oculomotor control and vision while encountering social stimuli using an anti-saccade paradigm. They found that inhibition of socially salient cues poses higher demands on the oculomotor system. Evidence also suggests that the presence of interlocutors in the environment can influence eye movements and spatial and temporal attention. In their study, Tricoche et al. (2020) investigated whether social attention influences decision making using three tasks – continuous performance task (CPT), anti-saccade, and visual search task. The social context was manipulated in the experiment by conducting the experiment either in the presence of a familiar peer or alone. They found that based on the social context, saccade latencies (in the anti-saccade task) and peak velocity of saccades were influenced, but this was dependent on the task complexity as well. The study provides evidence of the modulation of eye movements in different social contexts.

3.1.2 Interactional context and oculomotor control. In an interactional context, a person is not only encountering an interlocutor (not just mere presence), but there is active interaction with him or her. People try to establish joint attention by guiding their gaze to an object of common interest (Frischen, Bayliss, & Tipper, 2007). There is a constant exchange of thoughts and ideas; especially in a bi or multilingual context, the goals vary dynamically – that is, the language used for communication with an interlocutor might shift between L1 and L2 depending on the situation. Bilinguals often encounter and use more than one language in their social environment. Identifying

their interlocutor and accommodating their linguistic background is an essential aspect in such instances. Especially in bilinguals and multilinguals, the interactional settings they encounter is usually dynamic. For them to adapt to such situations, language selection, which requires executive control, is necessary. Factors like context, language preference of the interlocutor, socio-cultural factors, prior experiences, etc., can influence this language selection (Hartsuiker, 2015; Molnar et al., 2015; Rafeekh & Mishra, 2020).

Interestingly, the influence of interlocutors can also vary based on presence – present vs imagined, familiarity – known vs unknown, active vs passive spectators, and so on (Guerin, 2010; Reynaud, Guedj, Hadj-Bouziane, Meunier, & Monfardini, 2015). Since it is known that eye movements are influenced by social context (Riechelmann, Raettig, Böckler, & Huestegge, 2019; Salvia et al., 2020; Tricoche et al., 2020), it is possible to assume that interactional contexts also modulate oculomotor control. The present study attempts to see if the language identity of the interlocutor is capable of modulating oculomotor control.

Bilinguals' sensitivity to interlocutors can manifest in different forms, such as the language and cultural background of interlocutors and their language preference (Mishra, 2018) which helps them manage their language use. Blanco-Elorrieta and Pylkkänen (2017) explored how different bilingual contexts modulate language control networks. They observed interlocutor sensitivity between 100-300 ms following the interlocutor cue onset and increased activity on the anterior cingulate cortex, indicating its role in processing interlocutor-related information. They also found that interlocutor representations are decoded around 160 ms after the presentation of the interlocutor. This study is in line with existing findings that bilinguals proactively use the identity of the interlocutor to predict upcoming language (Blanco-Elorrieta & Pylkkänen, 2016; Martin et

al., 2016). Even passive (not actively engaged in the communication), inanimate objects tend to influence language production. Bhatia et al. (2017) found that in a voluntary naming study among Hindi-English bilinguals, participants tend to choose the language indicated by a cartoon present on the screen when it was irrelevant to the task. The visual cues present in the environment can influence bilinguals' language use -related decisions. To extend this idea further, an experiment was planned by bringing in a task-induced interactional context and tested if context defined as interlocutor proficiency or the language profile could regulate executive control, especially the oculomotor control. The results will also contribute to increased awareness of the debate and the incongruencies observed in the field of bilingualism, especially the bilingual advantage debate, since, to some extent, the interactional context and language experience of bilinguals account for the bilingual executive control advantage.

3.1.3 Present study. The study was designed to investigate how specific interactional contexts modulate the recruitment of inhibitory control, given the evidence that interactional contexts that call for language comprehension and production influence executive control (Adler, Valdés Kroff, & Novick, 2019; Beatty-Martínez & Dussias, 2017; Jiao et al., 2020), how the presence of interlocutors modulate executive control mechanisms, especially oculomotor control, was investigated. Also, the contribution of language experience of the participants while encountering such situations was also considered.

Exercise of more than one language can influence a myriad of cognitive functions leading to adaptive changes in the neuronal system (Green & Abutalebi, 2013). A significant amount of work has revealed that the anterior cingulate cortex and the prefrontal cortex are involved in language control (Abutalebi & Green, 2008; Blanco-Elorrieta & Pylkkänen, 2016, 2017; Kang et

al., 2017; but see Wu et al., 2020) and also implicated for cognitive control in general (Aron, Robbins, & Poldrack, 2014; Braver, Reynolds, & Donaldson, 2003; Thothathiri, Rattinger, & Trivedi, 2017). The generation, and suppression of saccades, involve various neuroanatomical structures, including the anterior cingulate cortex and dorsolateral prefrontal cortex (Heidlmayr, Doré-Mazars, Aparicio, & Isel, 2016). Though there seems to be an interesting relationship between various neural networks and structures, the current paper does not intend to look at the neuronal structures involved during the performance of a non-linguistic control task under different cognitive demands imposed by the interlocutor context.

Evidence suggests that both linguistic and visual context can influence saccadic eye movement (Mishra, Olivers, & Huettig, 2013). Keeping this in mind, an oculomotor version of the Stroop task (Hodgson, Parris, Gregory, & Jarvis, 2009; Singh & Mishra, 2012, 2013) was used to explore the modulatory effects of interactional context on oculomotor inhibitory control. This task contains components aimed at assessing components of executive control, including interference suppression/suppression of distractor location and goal-directed behaviour. The task requires the participants to make eye movements to a coloured square that matches the colour of the centrally presented line or arrow while ignoring the direction of the arrow. The task involves three types of trials – congruent, incongruent and neutral trials. The trials in which arrow direction matched the coloured square were considered as congruent trials, whereas on incongruent trials, the central arrow did not point towards the target square. On incongruent trials, participants have to hold back the automatic saccadic eye movements initiated by the central cue (inhibit looking towards the arrow direction), rather make voluntary eye movement towards the coloured square that corresponds to the colour of the central cue since arrows shift attention endogenously. Successful performance on this task thus calls for better oculomotor inhibition. Straight lines on the neutral

trials replaced the centrally presented arrows. Smaller Stroop effects (Saccade latency incongruent – saccade latency congruent) reflect better interference suppression/inhibitory control.

To examine if interactional contexts modulate oculomotor control, three types of interactional context (high-L2 proficient, low-L2 proficient, and neutral interlocutors) were introduced by manipulating the interlocutor proficiency through a familiarisation and interaction phase. The context in which high-L2 proficient interlocutor was introduced requires participants to use both L1 and L2, whereas the presence of low-L2 interlocutors induces more demands on the L1 system. The language identity of the neutral interlocutors was unknown to the participants and was introduced as a baseline measure for interlocutors. Based on previous studies and theoretical suggestions, it was hypothesised that if the task demands match the control requirements necessary for a particular interactional context, then participants will show better adaptation (reduced Stroop effect) to the task. This adaptation to the task may be in terms of faster saccade latencies or reduced error rates. That is, it was assumed that the presence of high-L2 proficient interlocutor induces higher demands on the executive control system leading to smaller Stroop effects. Since the demands on the control system are less in the presence of low-L2 proficient interlocutors, the hypothesis was that the Stroop effects would be the highest in their presence.

3.2 Method

3.2.1 Participants. Fifty-six high-L2 proficient Malayalam(L1)-English(L2) bilinguals ($M = 22.70$ years, $SD = 2.83$ years) from the University of Hyderabad were selected for the study. The participants acquired English (L2) around 5.1 years ($SD = 1.68$ years). Written consent was

obtained from all the bilinguals. The approval of the Institutional Ethics Committee (IEC) was obtained.

Table 8

Characteristics of participants in the study

	Mean	SD
Age	22.70	2.83
Age of Acquisition		
L1	1.23	0.79
L2	5.10	1.68
Years of formal education		
L1	2.88	4.15
L2	14.86	3.92
Language exposure (%)		
L1	39.11	13.14
L2	54.31	13.22
Self-reported proficiency		
L1	8.35	1.12
L2	8.59	0.74
Naming latency (in ms)		

L1	1146.49	175.22
L2	1144.80	185.62
Semantic fluency score		
L1	13.62	2.33
L2	14.55	2.21
WordORnot (L2 vocabulary score)	59	9.86
Switching frequency	5.27	1.69

3.2.2 Control tasks. The WordORnot was administered to measure the proficiency of participants in L2 (English). This is an online test and was conducted on a 15.6” hp laptop (. In the test, participants had to indicate whether the strings of letters were a “word” or a “non-word”; they were presented with 100 such instances. The mean score obtained on the test was 59% ($SD = 9.86\%$).

The semantic fluency task was administered to evaluate the verbal fluency of participants in both L1 (Malayalam) and L2 (English). They were instructed to say out loud as many words as they could of objects in 4 semantic classes, namely “birds”, “vegetables”, “animals”, and “fruits”. For each category, they were given a maximum time of 60 seconds, and the test was conducted in both languages. The semantic fluency scores were calculated by averaging the number of words produced per language. Participants’ score in L2 ($M = 14.55$, $SD = 2.21$) was significantly higher than L1 ($M = 13.62$, $SD = 2.33$), $t(51) = -2.06$, $p = .04$.

The object naming task in which participants had to name some pictures in both L1 and L2 based on language cues was also administered. Participants' naming latency on English ($M = 1144.80$ ms, $SD = 185.62$) was similar to Malayalam ($M = 1146.49$ ms, $SD = 175.22$), $t(51) = 0.04$, $p = .96$.

A language questionnaire was also administered to gather details about their language use (see Table 8 for details like the age of language acquisition, self-reported proficiency, etc.).

3.2.3 Interlocutor Stimuli. Three types of interlocutors were used in the study – high-L2 proficient, low-L2 proficient and neutral interlocutors. Except for neutral interlocutors, the rest of them spoke about a general topic (such as health, global warming, media, pollution, etc.) for 90 seconds. The high-L2 proficient interlocutor used both L1 (Malayalam) and L2 (English) equally, switching between the languages, whereas the low-L2 proficient interlocutor used L1 (Malayalam) mostly (90% of the time). The language profile or language identity of the neutral interlocutor was unknown to the participants. The cartoons used in the study was the same as the one mentioned in Chapter 2.

3.2.4 Procedure. The experiment started with a familiarisation phase followed by an interaction phase, the main task and the re-familiarisation phase. During the familiarisation phase, the participants saw the video clip of the interlocutors in which they spoke about a particular topic. Both male and female characters were used to avoid any kind of biases. The interaction phase which followed this involved participant responding to the questions (10 questions each) asked by the interlocutors. The high-L2 proficient interlocutor asked five questions in L1 and five in L2, whereas the low-L2 proficient interlocutor asked only two questions in L2 and the rest in L1. The

participants were free to choose the language in which they responded. Following the interaction phase, the participants proceeded to do the main task.

3.2.4.1 Oculomotor Stroop task. The task used in the experiment was adapted from Singh and Mishra (2013) for this study. The experiment comprised of a display of 4 coloured squares (red, blue, green and black) together with a central cue (arrow or straight line). The coloured squares subtended 1.6° visual angle at an eccentricity of 7.3° from the centre of the screen. These squares remained at the same location, red, blue, green and black at left, up, right and bottom locations simultaneously. Each square was 63×63 pixels, and the area of interest was 135×135 pixels. At the centre of the screen, either an arrow or a straight line (0.96×0.23 cm) appeared depending on the experimental condition (congruent, incongruent and neutral). The central cue could be of any of the four colours. In the congruent condition, the arrow direction and colour matched the coloured square (for instance, a blue arrow pointing the blue square), whereas, in the incongruent condition, there was a discrepancy (for example, a green arrow pointing at the black square). In the neutral condition, a straight line replaced the central arrow. The participants were asked to look at the square corresponding to the colour of the arrow/straight line while ignoring its direction. Each trial started with a fixation cross which remained on the screen till the participants fixated at it for a minimum of 500 ms. Following this, the coloured squares and the central cue appeared on the screen, and it stayed on till participants made a correct saccade to the target or until 1500 ms. The inter-trial interval was 1000 ms. The above sequence corresponded to the control condition.

In the interlocutor condition (Figure 10), an interlocutor appeared for 1500 ms following the fixation cross. Based on the type of interlocutor, the experiment consisted of three blocks –

high-L2 proficient, low-L2 proficient and neutral interlocutor block. During the re-familiarisation phase, the interlocutors appeared during the breaks and asked some questions. This was done to reinforce the language identity of the interlocutors.

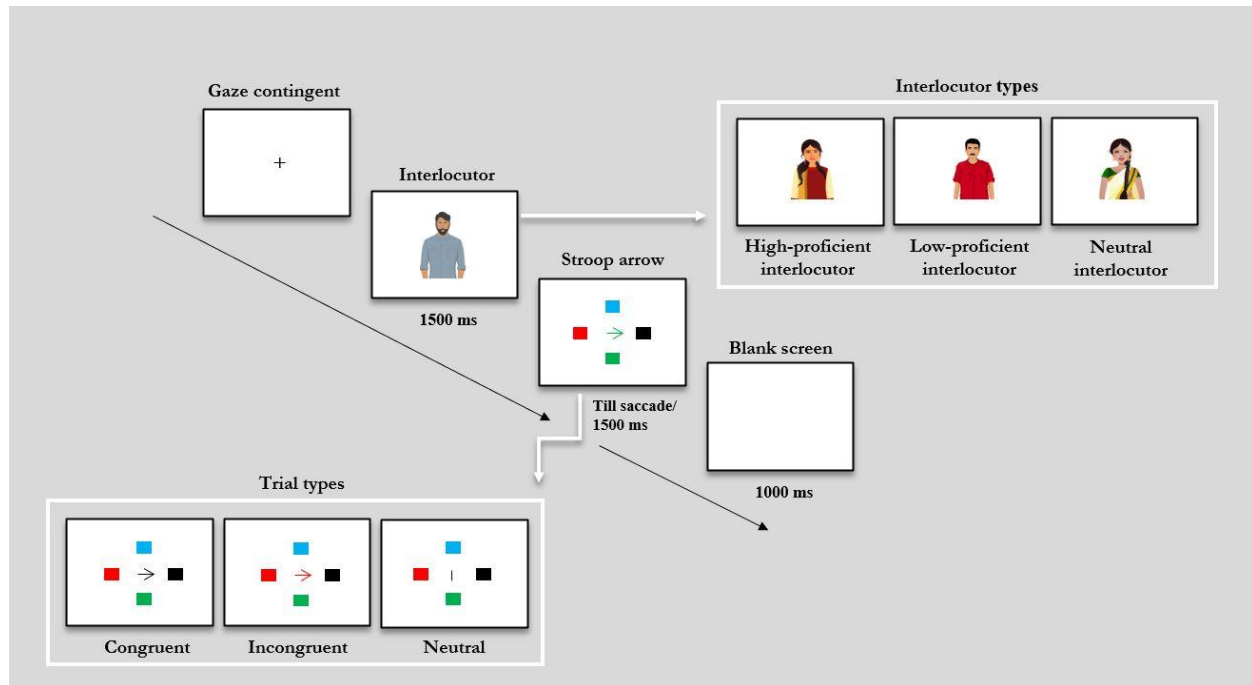


Figure 10. Schematic representation of oculomotor Stroop task incorporated with three interactional contexts.

3.2.5 Data pre-processing and analysis. Trials in which the participants blinked and also the trials that were too slow (latency more than 1500 ms) were not considered for the analysis. For analysis, all trial with latencies less than 80 ms (anticipatory saccades) and more than 1000 ms were discarded, followed by the omission of trials above or below three standard deviations from the mean saccade latency. Analysis was carried out only for correct trials. Due to technical errors as well as increased errors (more than 50% errors), 5 participants were removed from the final analysis. Following this, a repeated-measures ANOVA was carried out with interlocutor (high-L2

proficient, low-L2 proficient and neutral) and trial-type (congruent, incongruent and neutral) as within-subject factors.

3.3 Results

3.3.1 Saccade latency. The analysis showed that the main effect of interlocutor was significant, $F(1.774, 88.70) = 11.34$, $p < .001$, $\eta^2 = .18$, suggesting faster performance in the presence of high-L2 proficient interlocutor ($M = 304.56$ ms, $SE = 6.70$) compared to neutral ($M = 310.97$ ms, $SE = 6.81$) and low-L2 proficient interlocutor ($M = 324.30$ ms, $SE = 7.15$). Pairwise comparisons indicate that there was a significant difference between high-L2 proficient and low-L2 proficient interlocutor ($p < .001$), low-L2 proficient and neutral interlocutor ($p = .001$) and marginal significance between high-L2 proficient and neutral interlocutor ($p = .08$). The mean saccade latencies are shown in Table 9. The main effect of trial-type was also significant, $F(2, 100) = 60.72$, $p < .001$, $\eta^2 = .54$, indicating that participants were faster on congruent trial ($M = 300.91$, $SE = 6.02$) compared to incongruent ($M = 315.45$, $SE = 6.80$) and neutral trial ($M = 323.47$, $SE = 6.80$). Further, pairwise comparisons indicate that there was significant difference between all three types of trials ($p < .001$).

The interaction between interlocutor and trial-type was significant, $F(3.56, 178.21) = 2.92$, $p = .02$, $\eta^2 = .55$. On congruent trials, participants were faster in the presence of high-L2 proficient interlocutors ($M = 295.08$ ms, $SE = 6.62$); there was a significant difference between high-L2 proficient and low-L2 proficient ($M = 310.17$ ms, $SE = 6.64$) interlocutors ($p = .008$), as well as, low-L2 proficient and neutral ($M = 297.46$ ms, $SE = 6.64$) interlocutors ($p = .003$). However, no difference was observed between high-L2 proficient and neutral interlocutors ($p = .62$). Similarly, on neutral trials, there was a significant difference between high-L2 proficient ($M = 316.39$ ms,

$SE = 7.05$) and low-L2 proficient ($M = 335.35$ ms, $SE = 7.85$) interlocutors ($p = .003$), and low-L2 proficient and neutral ($M = 318.68$ ms, $SE = 7.34$) interlocutors ($p = .001$). The difference between high-L2 proficient and neutral interlocutors was absent ($p = .60$). On incongruent trials, there was a significant difference between high-L2 proficient ($M = 302.39$ ms, $SE = 7.04$) and low-L2 proficient ($M = 327.39$ ms, $SE = 7.91$) interlocutors ($p < .001$), high-L2 proficient and neutral ($M = 316.76$ ms, $SE = 7.08$) interlocutors ($p < .001$), as well as, low-L2 proficient and neutral interlocutors ($p = .03$). A close look at the interaction shows that participants were faster on all trial types, congruent ($M = 295.08$, $SE = 6.62$) and incongruent ($M = 310.17$, $SE = 6.64$) and neutral trials ($M = 297.46$, $SE = 6.64$), in the presence of high-L2 proficient interlocutor.

Table 9

Mean saccade latency under different experimental conditions

	Congruent	Incongruent	Neutral
High-L2 proficient interlocutor	295.08 (47.27)	302.21 (50.27)	316.39 (50.38)
Low-L2 proficient interlocutor	310.17 (47.45)	327.39 (56.54)	335.35 (56.10)
Neutral interlocutor	297.46 (47.46)	316.76 (50.58)	318.68 (52.46)
Control	358.20 (50.46)	394.40 (57.40)	396.60 (53.83)

Note. SD in parentheses

To see further how the interlocutor condition influenced their conflict resolution ability, the Stroop effect (SE) was calculated by subtracting saccade latency on congruent trials from incongruent trials to see further how the interlocutor condition influenced their conflict resolution ability (Figure 11). The results revealed a main effect of interlocutor, $F(2, 100) = 5.18$, $p = .007$,

$\eta^2 = .09$ indicating that conflict resolution was better in the presence of high-L2 proficient interlocutor ($M = 7.13$ ms, $SE = 2.98$) compared to low-L2 proficient ($M = 17.21$ ms, $SE = 3.50$) and neutral interlocutors ($M = 19.29$ ms, $SE = 2.99$). Pairwise comparisons indicate a significant difference between high-L2 proficient and low-L2 proficient interlocutor ($p = .02$) and high-L2 proficient and neutral interlocutor ($p = .007$). There was no significant difference between low-L2 proficient and neutral interlocutor ($p = .56$). Similarly, the Stroop interference effect (SIE) was calculated by subtracting the saccade latency on neutral trials from incongruent trials. We found that the main effect of interlocutor was marginally significant, $F(3.02, 92.65) = 3.02$, $p = .057$, $\eta^2 = .57$. Interestingly, the mean Stroop interference effect was -8.02 ms ($SE = 2.13$), suggesting that participants were faster on incongruent trials ($M = 315.45$ ms, $SE = 6.80$) compared to neutral trials ($M = 323.47$ ms, $SE = 6.80$), indicating that incongruent trials did not create a conflict in comparison to neutral trials. Hence, further analysis of SIE is not done. The Stroop facilitation effect (SFE) was calculated by subtracting the saccade latency on the congruent trial from the neutral trial. The results indicate that the main effect of interlocutor was absent, $F(2, 100) = 0.60$, $p = .55$, $\eta^2 = .01$.

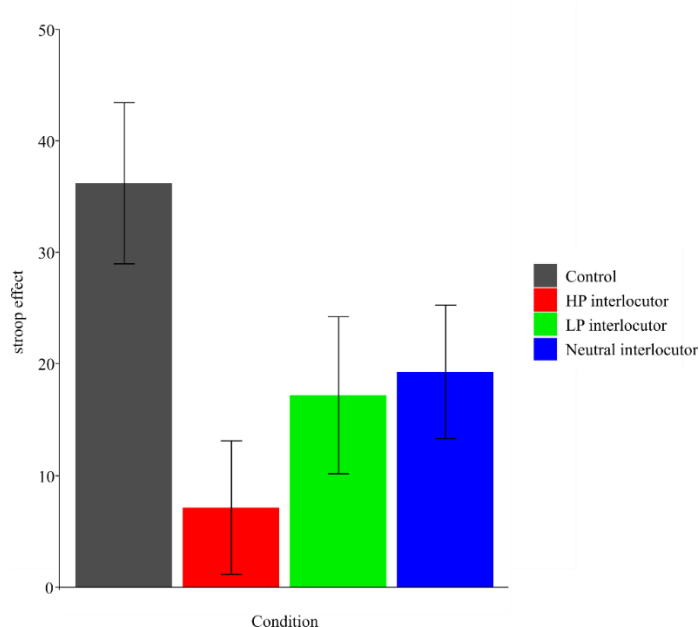


Figure 11. Stroop effect in the presence of different experimental conditions.

In the control task, the main effect of trial-type was significant, $F(2, 100) = 82.31, p < .001$, $\eta^2 = .62$, showing that participants were faster on congruent trials ($M = 358.20, SE = 7.06$) compared to incongruent ($M = 394.40$ ms, $SE = 8.03$) and neutral trials ($M = 396.60$ ms, $SE = 7.53$). There was a significant difference between congruent and incongruent ($p < .001$) as well as congruent and neutral trials ($p < .001$). However, the saccade latencies on incongruent and neutral trials ($p = .48$) did not differ much.

3.3.2 Error analysis. A repeated measures ANOVA was carried out on the error data with interlocutor and trial-type as within subject factors. The main effect of interlocutor was absent, $F(2, 100) = 2.02, p = .13, \eta^2 = .03$, suggesting that interlocutor condition did not affect error rates (Table 10). The main effect of trial-type was significant, $F(2, 100) = 67.52, p < .001, \eta^2 = .57$, showing significantly higher error rate on incongruent trials ($M = 0.089, SE = .009$) than on congruent ($M = 0.079, SE = 0.008$) and neutral trials ($M = 0.082, SE = 0.009$). However, pairwise

comparisons indicate that the difference between congruent and incongruent ($p = .07$), congruent and neutral ($p = .58$), and incongruent and neutral trials ($p = .15$) were not significant. The interaction between interlocutor and trial-type was absent, $F(4, 200) = 0.47$, $p = .75$, $\eta^2 = .009$.

Table 10

Mean error rates under different experimental conditions

	Congruent	Incongruent	Neutral
High-L2 proficient interlocutor	0.02 (0.02)	0.14 (0.11)	0.07 (0.06)
Low-L2 proficient interlocutor	0.02 (0.03)	0.14 (0.11)	0.09 (0.08)
Neutral interlocutor	0.02 (0.02)	0.14 (0.11)	0.07 (0.07)
Control	0.02 (0.03)	0.19 (0.15)	0.10 (0.08)

Note. SD in parentheses

In the control task, participants committed more errors on incongruent trials ($M = 0.19$, $SE = 0.02$) compared to neutral ($M = 0.10$, $SE = 0.01$) and congruent trials ($M = 0.02$, $SE = 0.006$), $F(1.32, 66.39) = 57.75$, $p < .001$, $\eta^2 = .53$.

3.3.3 Correlation. To explore the relationship between cognitive control and the bilingual language-related experiences of the participants, correlations were performed separately for stoop effect (Figure 12), Stroop interference and facilitation (Figure 13) effects with the language variables (age of acquisition of L2, years of education in L2, self-rated proficiency in L1 and L2, semantic fluency score in L1 and L2, exposure to L1 and L2, and vocabulary score in L2).

Stroop effect in the presence of high-L2 proficient interlocutor correlated negatively with self-rated proficiency in L2 ($\gamma = -.39$, $p = .004$) and exposure to L2 ($\gamma = -.35$, $p = .01$), and positively

correlated with L1 exposure ($\gamma = .32$, $p = .01$). It was observed that stroop effect in the control condition correlated positively with naming latencies in L2 ($\gamma = .31$, $p = .02$).

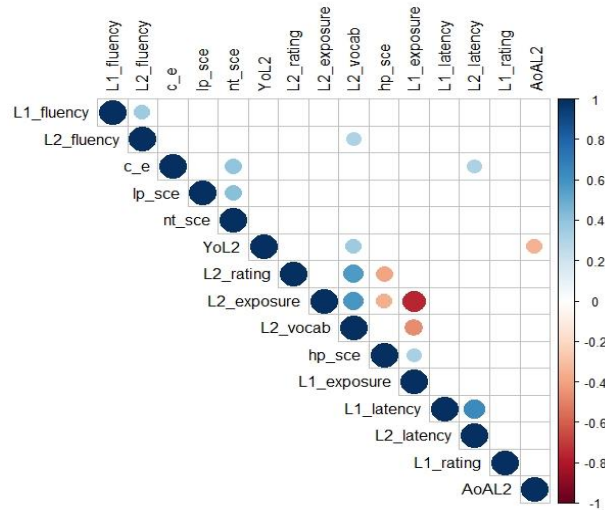


Figure 12. Correlation between Stroop effect and language variables

Stroop interference effect correlated negatively with self-rated proficiency in L2 ($\gamma = -.45$, $p < .001$). Interestingly, L2 exposure correlated positively with stroop interference effect in the control condition ($\gamma = .41$, $p = .002$). In the case of stroop facilitation effect, only L1 exposure had a positive correlation ($\gamma = .28$, $p = .04$).

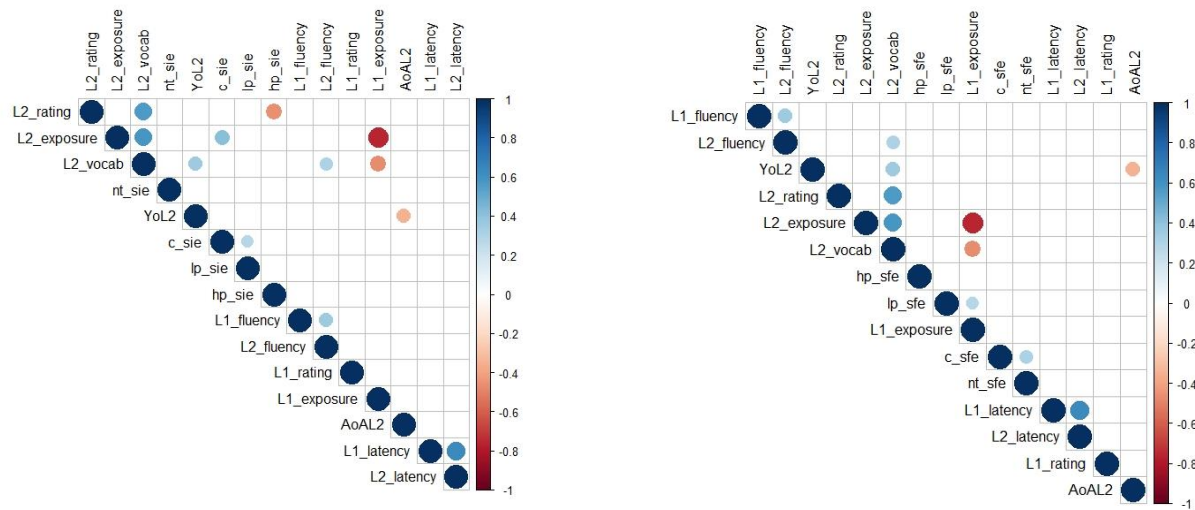


Figure 13. Correlogram of Stroop interference effect (left) and Stroop facilitation effect

3.4 Discussion

The study aimed to explore the effects of different interactional contexts on oculomotor inhibitory control. Three interactional contexts were created by presenting interlocutors of different language proficiencies – high-L2 proficient, low-L2 proficient and neutral interlocutors – and the performance of participants were compared across these conditions during an oculomotor Stroop task. The key findings from the study indicate that the demands of the interactional context did indeed modulate the engagement of inhibitory control. The performance of the participants varied across the three interactional contexts, and they were faster (in terms of saccade latency) when the task was followed by the presence of high-L2 proficient interlocutors. Crucially, this effect was linked to the language experience of the participants. The results contribute to the debate concerning bilingual advantage and whether bilingualism affects executive control processes by

pointing out the importance of understanding bilingual experience and communicative context. Further, this result extends the findings that interactional context modulates executive control in the oculomotor domain.

For bilinguals, managing the simultaneous activation of languages and the resulting language control adaptation can, in turn, modulate the domain-general executive control mechanisms. This modulation would later manifest while resolving a non-linguistic conflict. Thus, if the immediate context demands the modulation of the two languages, there will be a notable difference in executive control. The magnitude of language activation occurring is different for the different interactional contexts in the present study. For example, the presence of high-L2 proficient interlocutor tends to activate both L1 and L2, whereas low-L2 proficient interlocutor calls for higher L1 activation. Though the study did not require participants to interact with the interlocutors throughout the experiment, their presence can activate language representations associated with those interlocutors. It is known that the presence of social cues or stimuli in the context can influence both behavioural (eye movements, actions, etc.) and neurological aspects (Tricoche et al., 2020). Also, evidence from works inspecting the effect of social environment on language production shows that bilinguals modulate their language based on the context and tag specific languages to specific interlocutors (Kapiley & Mishra, 2019).

Bilinguals use this interlocutor identity to predict the upcoming language even before any auditory-linguistic cue (Martin et al., 2016). They activate mental representation underlying the spoken language. The participants in the present study were high-L2 proficient bilinguals, and their performance under different task conditions suggests that conflict resolution was better when attentional demands (measured in terms of interlocutor proficiency) are higher. That is,

participants were faster at programming their saccades towards the target while controlling interference from the central cue when the attentional demands from the interlocutors were high. A reduced Stroop effect marked their better conflict resolution in this condition. Considering this result in light of the adaptive control hypothesis, we believe that encountering a high-L2 proficient interlocutor calls for higher levels of attentional demands, which aids superior conflict resolution in their presence (Wu & Thierry, 2013). This conflict resolution advantage was manifested in two ways, overall speed advantage and lower Stroop effect. The participants were able to maintain their task goals as a result of their enhanced attentional system. The central arrows presented during the task can automatically orient attention to the pointed location and automatically activate the oculomotor system. The participants were required to constantly keep in mind their task, the inhibition of reflexive saccade and the programming of correct saccades. The interactional context, introduced by manipulating interlocutor proficiency, modulated the oculomotor control mechanisms to adapt to the varying demands. The presence of high-L2 proficient interlocutor calls for frequent instances of both the languages, which can lead to higher chances of language interference and conflict. This calls for efficient conflict monitoring, goal maintenance and inhibitory control to prevent and resolve conflict situations which are reflected in the overall pattern of results (see Singh & Mishra, 2013 for more on conflict monitoring and bilingual advantage).

Considering the language profiles of the interlocutors, it was hypothesized that participants would show better conflict resolution in the presence of neutral interlocutors compared to low-L2 proficient interlocutors owing to the uncertainty of language identity of the former. The results showed that the saccade latencies in the presence of low-L2 proficient and neutral interlocutors differed significantly; participants had faster mean saccade latency in the presence of neutral

interlocutors. However, this difference disappeared when Stroop effects were taken into consideration; Stroop effect in the presence of low-L2 proficient and neutral interlocutor did not differ. As mentioned above, the results from saccade latency show that participants responded faster on both trial types in the presence of neutral interlocutors, indicating an overall speed advantage (Hilchey & Klein, 2011). It is assumed that the characteristics of the interlocutor resulted in this pattern of outcome – the lack of knowledge about the language identity of the neutral interlocutor vs the demands to suppress L1 in the presence of a low-L2 proficient interlocutor. At present, the role of neutral interlocutors cannot be ruled out since the appearance of new interlocutors in real-life interactional context are indeed high.

Whether the language experience of the participants influenced the modulation of inhibitory control across interactional contexts was also explored. As mentioned earlier, the modulatory role of language use on cognitive control can be tested using the task-induced interactional context (Jiao et al., 2020). However, to get a clearer picture, correlation of different variables related to language experience with the saccade latencies obtained from different experimental conditions was carried out. The results indicate that the Stroop effect following the presence of high-L2 proficient interlocutor correlated negatively with self-rated proficiency in L2 and the percentage of L2 exposure. These results indicate that better proficiency and use of L2 can lead to better conflict resolution in a cognitively demanding situation. Modulation of cognitive control by lifelong bilingual experience has also been reported by many entries (Beatty-Martinez et al., 2019; Ooi et al., 2018). The results are consistent with the findings by Pot, Keijzer, and de Bot (2018), where they revealed that language use across different social environments along with contextual switching patterns predicted better Flanker performance (faster reaction time). The results obtained thus underscore the importance of considering language environment and

experience in bilingual research as pointed out by Green's behavioural ecology (2010), Green and Abutalebi's adaptive control hypothesis (2013), Hartanto and Yang's disparate interactional context (2016), Gullifer et al.'s language entropy (2018), and so many other researchers (Bialystok, 2017; Mishra, 2018; Surrain & Luk, 2019).

The data from the control experiment was considered as the baseline measure of inhibitory control. Participants responded faster on congruent in comparison to incongruent trials. However, no difference was observed between incongruent and neutral trials, indicating a deviation from the existing literature. Goldfarb and Henik (2007) observed instances where RTs on neutral trials were faster than congruent trials on a Stroop task and attributed it to the task demands and conflicts. Since the experimental conditions were randomised, half of the participants completed the control task following the interlocutor condition and vice versa. It is possible that the practice these participants received might have helped them to resolve the conflict on incongruent trials better. However, more research needs to be carried out to explain the pattern of results obtained. It is possible that the neutral trials did not serve their purpose, but the existing result says otherwise (see Singh & Mishra, 2012, 2013 for more details). How the performance of participants differed in different conditions with respect to the control condition was explored. Participants had an overall better performance in all the interlocutor conditions in comparison to the control condition, indicating that the presence of any interlocutor can bring down conflict resolution in the Stroop task. Similarly, the incongruent trials were faster than neutral trials in the interlocutor condition. More experiments need to be carried out to understand the influence of various cues that can act as neutral elements (for example, in the current study, a straight line was used as a neutral cue. What will happen if coloured squares are used instead?).

The presence of neutral trials in the experiment made it possible to calculate interference and facilitation effect. As mentioned in the above paragraph, the saccade latencies were faster for incongruent trials compared to neutral trials, and thus a negative Stroop interference effect in all the interlocutor conditions was seen. Hence, further explanation of the effects of various interlocutor conditions on Stroop interference and facilitation effects was not carried out. Another interesting factor that needs consideration is the nature of the task itself. Unlike behavioural studies measuring reaction time, a non-linguistic task which called for oculomotor control was used. The present study demonstrated that the modulatory effects of interactional contexts on the executive control mechanisms also generalise to ocular responses as well. The study is limited by the passive presence of interlocutors. Experiments should incorporate both linguistic as well as non-linguistic cues in the experiment to better comprehend the modulatory role of communicative contexts.

In conclusion, the findings from this experiment are in congruence with other studies investigating the role of interactional context on executive control. The results indicate that the mere presence of an interlocutor and the changes in interactional context can regulate oculomotor control. Also, better conflict resolution is observed when bilinguals encounter interlocutors similar to them (in terms of language proficiency). The studies focusing on the role of interactional context are important as they can contribute to a better understanding of the bilingual advantage hypothesis and domain-general executive control.

Chapter 4: Moving from Kerala to Hyderabad: Did I become better at interlocutor adaptation?

Abstract

No two bilinguals are alike; they might differ in their second language proficiency, the context in which they are situated and their patterns of language use and exposure. The study examined the impact of bilinguals' long-term language experience on cognitive resources through a longitudinal study. Proficient Malayalam-English bilinguals from two different geographical locations – University of Hyderabad and University of Kerala – were compared on a Flanker task-induced with three different interactional contexts distinguished by the second language proficiency of the interlocutors. The participants differed in terms of their daily language exposure to both Malayalam and English, which in turn reflected on the language used in different domains of life. Results showed that modulation of cognitive control depended on the task-induced interactional contexts as well as a long-term language experience. Only participants from the University of Hyderabad demonstrated superior conflict resolution in the presence of a high-L2 proficient interlocutor. The findings throw light on the importance of bilingual language experience and its modulatory role on the cognitive system.

4.1 Introduction

Interaction between two people involves a broad spectrum of actions encompassing the recognition and interpretation of verbal and non-verbal cues, production of appropriate responses and expectations to enhance the quality of interaction. The influence of context seems to be ubiquitous in day-to-day cognition and social interactions. Deciphering the context-dependent cues – both explicit and implicit – are important in situations that call for interaction, and it affects cognitive processing (Ibañez & Manes, 2012). Contextual cues provide meaning to ambiguous stimuli; the same stimuli can assume different meanings depending on the context. For example, some of the context-dependent aspects include face perception, language, decision making, behaviours, etc. For bilinguals, the pattern of language use along with the linguistic profile of the interlocutor is an important contextual cue. The simultaneous activation of both the languages (Colomé & Miozzo, 2010; Guo & Peng, 2006) and the interlocutors in the interactional context exerts influence on the lexical systems in bilinguals. The cortical areas associated with bilingual language control overlap with the areas associated with domain-general executive control. Hence, the bilingual experience can impact the domain-general control mechanisms both at the behavioural as well as the neural level (Abutalebi et al., 2008; Bialystok, 2017; Green & Abutalebi, 2013; Hartanto & Yang, 2020; Hernandez, Dapretto, Mazziotta, & Bookheimer, 2001). Taking into consideration the above, this study identifies the role of long-term language experience in a context and how it influences interlocutor adaptation and control mechanisms at the behavioural level.

Bilingualism is a sociocultural phenomenon that relies heavily on the social context. Adapting successfully to conversational demands is thus important for people in diverse social environments. Blanco-Elorrieta and Pykkänen (2017) identified that bilinguals process their

interlocutor's language identity between 100-300 ms. The influence of interlocutor's language identity on bilingual language comprehension and production has been already established (Kapiley & Mishra, 2019; Martin et al., 2016; Molnar et al., 2015). Though studies have identified shown the relationship between interactional context and cognitive processing, how the interlocutor identity modulates cognitive control needs further exploration (Rafeekh & Mishra, 2020). The current study recognises the role of the interlocutor's linguistic profile, especially the variation in second language proficiency, during social interactions and tries to identify what role it plays in adaptation to a specific interactional context.

Recent evidence suggests that the differences associated with bilingual experience are a major contributing factor of enhanced executive functions in bilinguals (Gallo, Novitskiy, Myachykov, & Shtyrov, 2020; Gullifer & Titone, 2019; Paap et al., 2015; Paap, Johnson, & Sawi, 2016; Yang et al., 2016a). Ooi et al. (2018) investigated the role of bilingual experience on attentional control by comparing four groups of participants – monolinguals from Edinburgh, non-switching early and late bilinguals from Edinburgh and Singapore bilinguals. They identified a relation between language switching and control mechanisms using the ANT and TEA Elevator Task. Similarly, Bonfieni et al. (2019b) have identified that second language proficiency, as well as the nature of bilingual language experience (active vs passive), can modulate cognitive control mechanisms. Learning a second language can lead to both structural as well as neural changes (Beatty-Martínez & Dussias, 2019). Studies have shown that these changes are not restricted to language-related brain areas but also in the domain-general cognitive control areas. Considering the communicative environment while exploring the cognitive consequences of bilingualism is also important due to the inconsistencies in the literature exploring the same (Paap & Greenberg, 2013; Paap et al., 2015).

4.1.1 Relocation and Bilingualism. Have you ever found it hard to shift to the local language in a new city, imagining you know that language? At first, it might require a lot of mental effort to use the language, but over time, you will find yourself speaking in that language without any effort. The language choice of a bilingual speaker is determined or influenced by the conversation partners/interlocutors. Previous researchers have shown that bilinguals associate different languages with different interlocutors based on their language profile and use this information to interact with them. Imagine yourself as the bilingual speaker in Figure 14. You will find yourself using L1 in a context where the use of L1 is predominant (context A). For example, at home, you might use L1 rather than L2. Whereas, in a context that predominantly uses L2 (context B), you will be comfortable using L2 and not L1; for example, using L2 during an interview. In a context where people use both L1 and L2 (context C), the language selection of the bilingual speaker is influenced by the interlocutors' language choice (Kapiley & Mishra, 2019). In a classroom, you might use L1 while conversing with your friend and simultaneously use L2 while talking to your supervisor. What happens when you shift from an L1 dominant context to a highly bilingual context? The objective of this study was to see if long-term bilingual experience can contribute to changes in executive control and whether this influences interlocutor adaptation.

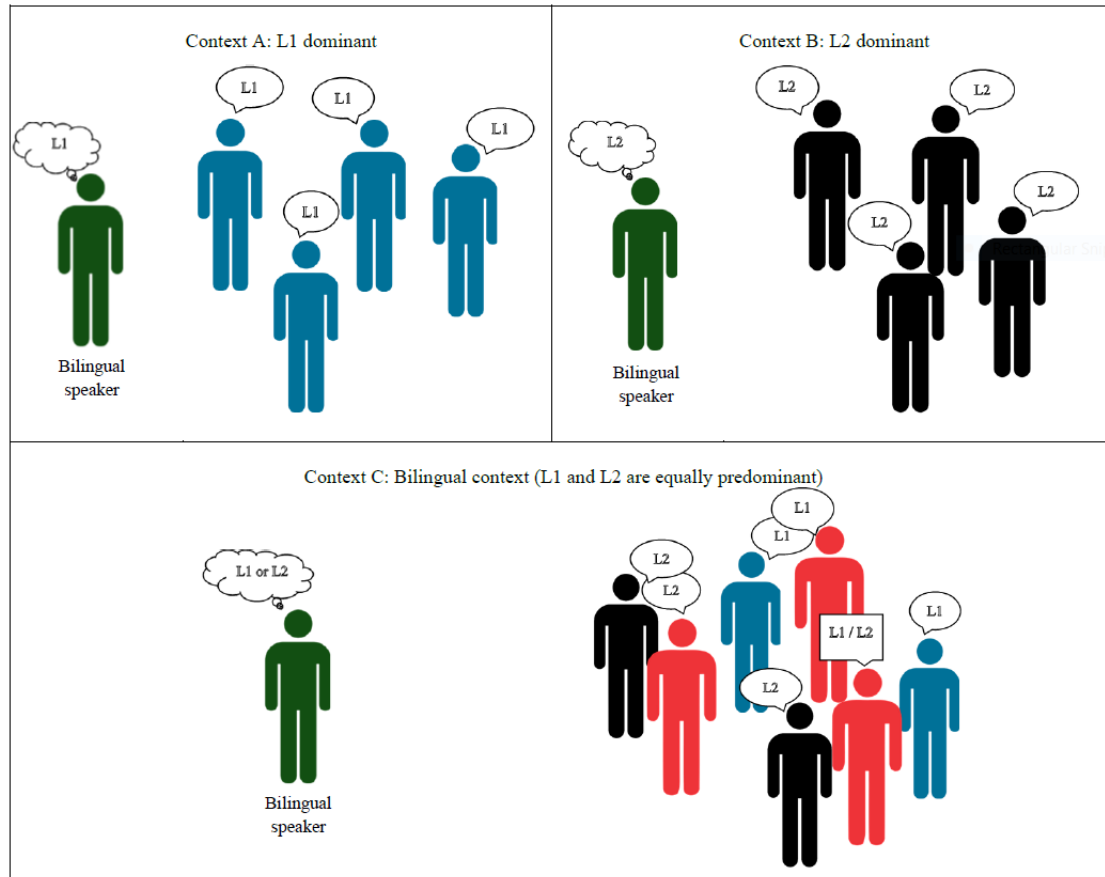


Figure 14. Language selection of a bilingual in different contexts.

The identification and selection of language by the speaker involve the utilisation of executive functions. In a multilingual communicative context, the demands imposed on the speaker is high since, in addition to conversing with a certain interlocutor, they are expected to suppress irrelevant information (filtering out irrelevant interlocutors) and selection of the appropriate target. Thus, studying interaction in a communicative context is important as it helps in identifying actions that produce a successful outcome.

The researchers that have looked at the role of cultural or communicative context have always manipulated the experiment to bring in the idea of a communicative situation; participants are often introduced to pictures that represent different interactional contexts to see how adaptation

to different contexts occur and the cognitive control changes associated with this. Some studies have compared bilinguals and monolinguals or bilinguals with varying language proficiency from different geographical locations on executive function task to see the direct influence of real-world interactions on cognitive control. The present study is an attempt to combine both approaches. In addition to examining how interlocutor adaptation occurs in a new bilingual environment, how the language use and exposure, an instance of long-term language experience, contributes to this was also incorporated. The study intended to explore this by comparing participants from two geographical locations who varied in their second language use at different time points. Through carefully controlled longitudinal studies and consideration of various factors such as incorporating environmental and language-related factors, controlling the heterogeneity of the two groups, etc., these inconsistencies and lack of clarity in the field can be avoided.

4.1.2 Current study. The first study (Chapter 2) found that different interactional contexts engage executive control demands differently. This relationship was further influenced by the increased use and exposure to the second language, as indicated by the correlation between task performance and the percentage of L2 exposure. Given the need to identify and clarify the mechanisms underlying bilinguals' ability to adapt to interlocutors of different linguistic abilities, the present study investigated whether differing language experiences could help explain the cognitive mechanisms involved in interlocutor adaptation. For the same, the study combined two approaches – (a) the use of task-induced interactional context and (b) the use of long-term language experience. The task-induced interactional context was created by presenting cartoons with varying second language proficiencies; the L1 proficiency of the cartoons remained the same. To incorporate the long-term language experience, participants from two geographical locations that differed in language use and exposure was considered. Thus, the present study considered

participants from the University of Hyderabad and the University of Kerala – who were matched carefully to control for potentially confounding variables – and were compared on the Flanker task incorporated with different interactional contexts. Care was taken to collect in detail the language use and exposure of participants (Table 12) in various interactional situations to explore its contributory role.

The presence of varying interlocutors in a communicative context and constant interactions with them can impact the cognitive control system in distinct ways. Using longitudinal studies, researchers can explore how these language experiences modulate cognitive control while avoiding the limitations of quasi-experimental designs. These studies are capable of unfolding how bilinguals' language experience can influence their executive control, importantly, how they adapt to their interlocutors. Hence, the present study was designed to capture these relationships; data collection was carried out at two time points, and the performance of the participants was compared at the two time points. Correlation of different variables with the performance of the participants was also done at both the time points to see if the relationship between the variables changes over a period of time and if particular variables contribute to task performance. Since the participants were matched, a difference in the performance of the participants was not expected at Time point 1 (T1). Second language training studies have indicated that dynamic practice of a second language can lead to advantages in the cognitive system which can be measured using control tasks (Bak, Long, Vega-Mendoza, & Sorace, 2016; Rafeekh et al., 2021; but see Ramos et al., 2017). Hence a reduced conflict effect for participants from the University of Hyderabad was expected on the control task. Due to the increased use of both the languages in participants from the University of Hyderabad, the conflict effect in the presence of different interlocutors was expected to be different

(reduced considerably) at T2. Both groups of participants were expected to be faster at T2 owing to the similarity effect.

4.2 Method

4.2.1 Participants. Thirty Malayalam(L1)-English(L2) bilinguals (5 males, $M = 21.27$ years, $SD = 0.82$) from the University of Hyderabad and thirty Malayalam-English bilinguals (7 males, $M = 21.63$, $SD = 0.80$) from the University of Kerala were recruited for the study. The participants acquired English around the age of 4.23 ($SD = 0.85$), and their medium of instruction at school and college was English. The participants from the University of Hyderabad and the University of Kerala were recruited as soon as they joined the University. Measures were taken to ensure that the participants in both groups completed their studies in Kerala, and there was no or little difference between the two groups. The IEC approved the study, and written consent was obtained from all the participants. The data for the study was collected at two time points June-July (T1) and December-January (T2). All the participants in the study were high-L2 proficient bilinguals.

Table 11

Participant details

	University of Kerala	University of Hyderabad
Age	21.63 (0.80)	21.27 (0.82)
Age of acquisition of		
L1	0.63 (0.49)	0.60 (0.49)
L2	4.27 (1.08)	4.20 (0.55)
WordORnot		

T1	46.63 (10.33)	46.67 (13.59)
T2	51.37 (10.36)	54.27 (12.24)
Naming latency (in ms) at T1		
L1	1233.89 (224.25)	1222.78 (131.86)
L2	1126.43 (197.07)	1142.33 (152.62)
Naming latency (in ms) at T2		
L1	1187.53 (165.49)	1111.86 (191.55)
L2	1105.46 (168.18)	1061.60 (162.46)
Exposure to L1		
T1	47.47 (5.55)	44.77 (13.06)
T2	50.33 (9.73)	32.17 (15.95)
Exposure to L2		
T1	44.67 (9.43)	46.30 (9.79)
T2	44.57 (10.60)	59.77 (18.86)

Note. SD in parentheses

4.2.2 Language measures.

4.2.2.1 LEAP Questionnaire. The Language Experience and Proficiency Questionnaire (LEAP-Q) was used to collect the language background details of the participants (Marian, Blumenfeld, & Kaushanskaya, 2007). It captures information regarding the acquisition of languages, self-rated proficiency, the extent of language exposure in different contexts (on a scale of 0-10 with 0 indicating never and 10 indicating always), percentage of language preference and also the contribution of various contexts during language learning. Participants were asked to fill in the details, and it took about 10 minutes to complete the questionnaire.

For participants from University of Kerala, the percentage of exposure to L1 ($p = .15$; T1: $M = 47.47\%$, $SD = 5.55$, T2: $M = 50.33\%$, $SD = 9.73$) as well as L2 ($p = .97$; T1: $M = 44.67\%$, $SD = 9.43$, T2: $M = 44.57\%$, $SD = 10.60$) did not differ across the two time points. The self-rated proficiency in L1 for speaking ($p = .29$; T1: $M = 8.43$, $SD = 1.33$, T2: $M = 8.20$, $SD = 0.92$), understanding ($p = .87$; T1: $M = 8.87$, $SD = 1.22$, T2: $M = 8.83$, $SD = 0.79$) and reading ($p = .36$; T1: $M = 8.63$, $SD = 1.58$, T2: $M = 8.90$, $SD = 0.75$) remained similar at the two time points. The self-rated proficiency in L2 for speaking ($p = .64$; T1: $M = 7.50$, $SD = 1.00$, T2: $M = 7.57$, $SD = 0.62$), understanding ($p = .44$; T1: $M = 8.13$, $SD = 0.77$, T2: $M = 8.23$, $SD = 0.93$) and reading ($p = .52$; T1: $M = 8.60$, $SD = 0.89$, T2: $M = 8.73$, $SD = 0.94$) did not differ across the two time points. The exposure to L1 and L2 in different contexts are given in Table 12.

Table 12

Current exposure to L1 and L2 across different contexts

University of Kerala						
Context	L1			L2		
	T1	T2	t	T1	T2	t
Friends	8.60 (1.47)	8.63 (0.71)	-0.11	5.77 (2.04)	6.00 (1.70)	-0.50
Family	9.57 (1.04)	9.37 (0.66)	1.03	3.83 (1.94)	3.77 (1.79)	0.22
TV	7.27 (2.27)	7.27 (1.25)	0.00	6.83 (2.05)	6.47 (1.61)	1.00
Radio/Music	6.87 (2.41)	6.43 (1.83)	1.00	5.47 (1.83)	5.30 (2.21)	0.43
Reading	6.33 (2.79)	5.90 (1.86)	1.04	8.80 (0.99)	9.10 (0.40)	-1.66
Self-instruction	6.30 (2.73)	6.50 (1.97)	-0.47	7.43 (1.50)	7.20 (1.27)	0.65
University of Hyderabad						

Context	L1			L2		
	T1	T2	t	T1	T2	t
Friends	6.47 (2.08)	5.43 (2.06)	2.13*	7.80 (1.40)	8.53 (0.62)	-2.75*
Family	9.43 (0.85)	9.13 (0.81)	1.79	3.73 (1.68)	3.70 (1.29)	0.09
TV	5.30 (2.52)	5.17 (1.08)	0.27	6.63 (2.15)	7.10 (1.24)	-1.21
Radio/Music	4.73 (2.37)	4.63 (1.54)	0.22	5.23 (1.47)	5.97 (2.02)	-1.86
Reading	4.83 (2.85)	4.50 (1.33)	0.61	9.00 (0.74)	9.13 (0.77)	-0.70
Self-instruction	6.53 (2.17)	6.43 (2.54)	0.21	7.63 (1.12)	7.93 (1.48)	-1.00

Note. * denotes $p < 0.05$; SD in parentheses

For participants from University of Hyderabad, the percentage of exposure to L1 ($p = .002$; T1: $M = 44.77\%$, $SD = 13.06$, T2: $M = 32.17\%$, $SD = 15.95$) decreased significantly whereas L2 exposure ($p = .003$; T1: $M = 46.30\%$, $SD = 9.79$, T2: $M = 59.77\%$, $SD = 18.86$) increased significantly over time. The self-rated proficiency in L1 for speaking ($p = 1.00$; T1: $M = 8.30$, $SD = 1.11$, T2: $M = 8.30$, $SD = 0.75$), understanding ($p = .66$; T1: $M = 8.73$, $SD = 1.01$, T2: $M = 8.80$, $SD = 0.80$) and reading ($p = .90$; T1: $M = 8.77$, $SD = 1.45$, T2: $M = 8.80$, $SD = 0.92$) remained similar at the two time points. The self-rated proficiency in L2 in understanding ($p = .65$; T1: $M = 8.17$, $SD = 1.08$, T2: $M = 8.27$, $SD = 0.74$) and reading ($p = .73$; T1: $M = 8.63$, $SD = 0.80$, T2: $M = 8.70$, $SD = 0.91$) did not differ across the two time points. However, the self-rated proficiency in L2 speaking improved ($p = .002$) at T2 ($M = 8.03$, $SD = 0.61$) compared to T1 ($M = 7.57$, $SD = 0.56$).

4.2.2.2 WordORnot. The WordORnot task was used to calculate the L2 proficiency of the participants. The L2 proficiency of the participants from University of Kerala improved significantly at T2 ($M = 51.37$, $SD = 10.36$) compared to T1 ($M = 46.63$, $SD = 10.34$), $t(29) = -$

3.46, $p = .002$. Similarly, participants from University of Hyderabad had better vocabulary score at T2 ($M = 54.27$, $SD = 12.24$) compared to T1 ($M = 46.67$, $SD = 13.59$), $t(29) = -8.35$, $p < .001$.

4.2.2.3 Object naming task. As an objective measure of language proficiency in both languages, the object naming task was administered to the participants. Participants saw a fixation cross for 1000 ms followed by a green/red square which indicated the language to be used while naming the picture. These language cues were presented for 2000 ms; the language associated with the cues were counterbalanced across participants. Line drawings of daily objects were then presented, and the participants had to name the same according to the language cue. The objects stayed on the screen until the voice key was triggered (considered as naming latency) or for 3000 ms. The naming latencies were calculated for each language after removing trials less than 150 ms and incorrect trials.

For participants from University of Kerala, the naming latencies in L1 stayed the same at both the time points (T1: $M = 1233.89$ ms, $SD = 224.25$, T2: $M = 1187.53$ ms, $SD = 165.49$), $t(29) = 1.65$, $p = .18$. The naming latencies in L2 also did not differ between the two time points (T1: $M = 1126.43$ ms, $SD = 197.07$, T2: $M = 1105.46$ ms, $SD = 168.18$), $t(29) = 0.86$, $p = .39$.

The naming latencies in L1 reduced significantly at T2 ($M = 1111.86$ ms, $SD = 191.55$) compared to T1 ($M = 1222.78$ ms, $SD = 131.86$) for participants from University of Hyderabad, $t(29) = 4.13$, $p < .001$. Similarly, naming latencies in L2 also reduced significantly at T2 ($M = 1061.60$ ms, $SD = 162.46$) compared to T1 ($M = 1142.33$ ms, $SD = 152.62$), $t(29) = 3.11$, $p = .004$.

4.2.3 Flanker task. The task started with a fixation cross presented at the centre of the screen for 500 ms, followed by flanker arrows for 1700 ms. The task constituted both congruent ($\rightarrow\rightarrow\rightarrow\rightarrow\rightarrow$ or $\leftarrow\leftarrow\leftarrow\leftarrow\leftarrow$) and incongruent ($\rightarrow\rightarrow\leftarrow\rightarrow\rightarrow$ or $\leftarrow\leftarrow\rightarrow\leftarrow\leftarrow$) trials. The participants were asked to respond to the central arrows by pressing “A” if it pointed towards the

left and “L” if the central arrow pointed towards the right. Following this, a blank screen appeared for 1000 ms. The control task consisted of 160 practice trials. The main experiment was similar to Experiment 1 used in Chapter 2 (refer to Figure 3). The three interlocutors (high-L2 proficient, low-L2 proficient and neutral interlocutors) was presented before each trial for 1500 ms. The presentation of these interlocutors was blocked, and the blocks were randomized. There was a total of 480 trials with 160 trials in each interlocutor condition. An equal number of congruent and incongruent trials were used in the task.

4.3 Results

4.3.1 Reaction time data. Before analysing the data, all the missing trials were removed. Following this, RTs below and above two standard deviations from the mean were also discarded. Following this, all the incorrect trials were removed. The remaining data were analysed using repeated-measures ANOVA with time (T1, T2), interlocutor (high-L2 proficient, low-L2 proficient and neutral) and trial (congruent and incongruent) as within-subject factors and group (University of Hyderabad and University of Kerala) as the between-subject factor.

The performance of the participants were faster at T2 ($M = 566.54$ ms, $SE = 9.95$) compared to T1 ($M = 586.51$ ms, $SE = 10.10$), $F(1,58) = 3.92$, $p = .05$, $\eta^2 = 0.06$. The main effect of interlocutor was present, $F(2, 116) = 7.39$, $p = .001$, $\eta^2 = .11$. Participants were faster in the presence of high-L2 proficient interlocutors ($M = 571.00$ ms, $SE = 8.64$) compared to low-L2 proficient ($M = 574.93$ ms, $SE = 8.90$) and neutral interlocutors ($M = 583.65$ ms, $SE = 9.10$). There was a significant difference between high-L2 proficient and neutral interlocutor ($p < .001$) as well as low-L2 proficient and neutral interlocutor ($p = .01$); however, the difference between high-L2 proficient and low-L2 proficient was not significant ($p = .29$). The participants were faster on congruent ($M = 555.32$ ms, $SE = 8.59$) compared to incongruent trials ($M = 597.73$ ms, $SE = 8.81$)

which was indicated be a main effect of trial type, $F(1,58) = 766.45$, $p < .001$, $\eta^2 = .93$. The main effect of group was not present, $F(1,58) = 0.04$, $p = .82$, $\eta^2 = .001$; there was no difference between participants from University of Hyderabad ($M = 574.62$ ms, $SE = 12.26$) and University of Kerala ($M = 578.43$ ms, $SE = 12.26$).

There was a significant interaction between time and group, $F(1,58) = 13.32$, $p < .001$, $\eta^2 = .18$. At T1, there was no significant difference between participants from University of Hyderabad ($M = 602.99$ ms, $SE = 14.28$) and University of Kerala ($M = 570.03$ ms, $SE = 14.28$). However, at T2, the reaction time of participants from University of Hyderabad ($M = 546.24$ ms, $SE = 14.07$) was much faster compared to participants from University of Kerala ($M = 586.83$ ms, $SE = 14.07$). Also, the participants from University of Hyderabad were significantly faster ($p < .001$) at T2 ($M = 546.24$ ms, $SE = 14.07$) compared to T1 ($M = 602.99$ ms, $SE = 14.28$); however, the performance did not differ ($p = .24$) for participants from University of Kerala between the two time points (T1: $M = 570.03$ ms, $SE = 14.28$; T2: $M = 586.83$ ms, $SE = 14.07$). The two-way interaction between interlocutor and group was not significant, $F(2,116) = 0.16$, $p = .84$, $\eta^2 = .003$.

Similarly, the interactions between time and interlocutor failed to reach significance, $F(2,116) = 0.72$, $p = .48$, $\eta^2 = .01$. Also, the interaction between interlocutor and trial was not significant, $F(2,116) = 1.79$, $p = .17$, $\eta^2 = .03$. However, the interaction between trial and group was marginally significant, $F(1,58) = 3.81$, $p = .055$, $\eta^2 = .06$; indicating that participants were faster on congruent compared to incongruent trials across both the groups – University of Hyderabad (congruent trial: $M = 554.91$ ms, $SE = 12.15$; incongruent trial: $M = 594.32$ ms, $SE = 12.46$) and University of Kerala (congruent trial: $M = 555.73$ ms, $SE = 12.15$; incongruent trial: $M = 601.13$ ms, $SE = 12.46$). It was also observed that the interaction between time and trial was statistically significant, $F(1,58) = 6.51$, $p = .01$, $\eta^2 = .10$. A closer look at the pairwise comparisons

indicated that participants' performance on incongruent trials improved significantly at T2 ($M = 585.80$ ms, $SE = 10.16$) compared to T1 ($M = 609.65$ ms, $SE = 10.45$). However, there was no difference in the reaction time on congruent trials between T1 ($M = 563.97$ ms, $SE = 9.88$) and T2 ($M = 547.27$ ms, $SE = 9.84$).

Table 13

Mean reaction time of participants across different experimental conditions

	University of Hyderabad				University of Kerala			
	T1		T2		T1		T2	
	C	IC	C	IC	C	IC	C	IC
HP	580.60	625.32	521.84	546.24	537.81	587.13	562.33	606.72
	(82.99)	(84.16)	(65.12)	(64.89)	(73.08)	(82.09)	(85.64)	(86.32)
LP	575.02	619.99	529.60	571.97	543.23	593.20	561.84	604.58
	(85.48)	(85.07)	(62.20)	(65.65)	(70.93)	(79.13)	(89.95)	(100.40)
NT	585.64	631.40	536.76	571.03	557.90	600.89	571.28	614.27
	(71.15)	(78.09)	(68.47)	(72.24)	(92.59)	(91.10)	(98.64)	(93.96)
Control	490.04	547.11	460.41	497.58	475.09	533.65	464.94	519.61
	(81.31)	(92.16)	(54.13)	(49.41)	(94.38)	(76.27)	(56.09)	(56.06)

Note. C: Congruent trial, IC: Incongruent trial; HP: high-L2 proficient interlocutor, LP: Low-L2 proficient interlocutor, NT: Neutral interlocutor; SD in parentheses

The three-way interaction indicated that there was an interaction between time, interlocutor and group; $F(2, 116) = 2.94$, $p = .05$, $\eta^2 = .04$. Pairwise comparisons were carried out to understand the interaction and it revealed interesting pattern of results. For the participants from

University of Kerala, there was no significant difference in the performance at T1 ($M = 562.47$ ms, $SE = 14.56$) and T2 ($M = 584.52$ ms, $SE = 13.82$) in the presence of high-L2 proficient interlocutor ($p = .13$). The results stayed similar in the presence of both low-L2 proficient ($p = .31$; T1: $M = 568.22$ ms, $SE = 14.54$; T2: $M = 583.21$ ms, $SE = 14.66$) and neutral interlocutors ($p = .41$; T1: $M = 579.40$ ms, $SE = 15.13$; T2: $M = 592.77$ ms, $SE = 15.27$). Interestingly, for participants from University of Hyderabad, the reaction time was faster at T2 compared to T1 in the presence of high-L2 proficient ($p < .001$; T1: $M = 602.96$ ms, $SE = 14.56$; T2: $M = 534.04$ ms, $SE = 13.82$) low-L2 proficient ($p = .003$; T1: $M = 597.50$ ms, $SE = 14.54$; T2: $M = 550.79$ ms, $SE = 14.66$) and neutral ($p = .001$; T1: $M = 608.52$ ms, $SE = 15.13$; T2: $M = 553.89$ ms, $SE = 15.27$) interlocutors. The interaction between time, trial and group was not significant, $F(1,58) = 1.48$, $p = .22$, $\eta^2 = .02$. Also, the interaction between time, interlocutor and trial was absent, $F(2,116) = 2.08$, $p = .12$, $\eta^2 = .03$.

The interaction between interlocutor, trial and group was marginally significant, $F(2,116) = 2.55$, $p = .08$, $\eta^2 = .04$. However, there was a significant difference between ($p = .006$) high-L2 proficient ($M = 550.07$ ms, $SE = 12.16$) and neutral interlocutor ($M = 564.59$ ms, $SE = 13.13$) as well as between ($p = .02$) low-L2 proficient ($M = 552.53$ ms, $SE = 12.25$) and neutral interlocutor on congruent trials for participants from University of Kerala. On incongruent trials, they had slower reaction time in the presence of neutral interlocutors ($M = 607.58$ ms, $SE = 12.78$) compared to high-L2 proficient ($p = .01$; $M = 596.93$ ms, $SE = 12.43$) and low-L2 proficient ($p = .07$; $M = 598.89$ ms, $SE = 13.09$) interlocutors. In the case of participants from University of Hyderabad, the performance on congruent trials differed while encountering interlocutors of different language profiles; participants were slower in the presence of neutral interlocutors ($M = 561.20$ ms, $SE = 13.13$) compared to high-L2 proficient ($M = 551.22$ ms, $SE = 12.16$) interlocutors ($p = .05$).

However, there was no difference in the performance between high-L2 proficient and low-L2 proficient ($M = 552.31$ ms, $SE = 12.25$) interlocutors ($p = .84$) as well as between low-L2 proficient and neutral interlocutors ($p = .09$). Importantly, on incongruent trials, there was a marginal significant difference between high-L2 proficient and low-L2 proficient interlocutors ($p = .06$) as well as between high-L2 proficient and neutral interlocutors ($p = .001$); participants were faster in the presence of high-L2 proficient ($M = 585.78$ ms, $SE = 12.43$) compared to low-L2 proficient ($M = 595.98$ ms, $SE = 13.09$) and neutral ($M = 601.21$ ms, $SE = 12.78$) interlocutors.

The four-way interaction between time, interlocutor, trial and group was statistically significant, $F(2,116) = 3.32$, $p = .04$, $\eta^2 = .05$. For participants from University of Kerala, at T1, there was a significant difference between reaction times in the presence of high-L2 proficient interlocutor and neutral interlocutor on both congruent ($p = .008$; high-L2 proficient interlocutor: $M = 537.81$ ms, $SE = 14.27$; neutral interlocutor: $M = 557.90$ ms, $SE = 15.07$) and incongruent trials ($p = .01$; high-L2 proficient interlocutor: $M = 587.13$ ms, $SE = 15.17$; neutral interlocutor: $M = 600.89$ ms, $SE = 15.49$). However, for participants from University of Hyderabad, the reaction times did not differ in the presence of different interlocutors across both congruent and incongruent trials at T1. For participants from University of Kerala, the difference between interlocutors on the two trials disappeared at T2. For participants from University of Hyderabad at T2, there was a significant difference between high-L2 proficient ($M = 546.24$ ms, $SE = 13.93$) and low-L2 proficient ($M = 571.97$ ms, $SE = 15.48$) interlocutors ($p = .001$), as well as high-L2 proficient and neutral ($M = 571.03$ ms, $SE = 15.30$) interlocutors ($p < .001$) on incongruent trials. On congruent trials, there was significant difference between high-L2 proficient ($M = 521.84$ ms, $SE = 13.89$) and neutral ($M = 539.76$ ms, $SE = 15.50$) interlocutors ($p = .04$). Thus, at T2 (time-point 2), the

interactional context played a role in modulating the adaptation to interlocutors of different nature only for participants from University of Hyderabad.

4.3.2 Conflict effect. Repeated measure ANOVA was carried out on the conflict effect data (RT incongruent – RT congruent) with time (T1, T2) and interlocutor (high-L2 proficient, low-L2 proficient and neutral interlocutors) as within-subject factors and group (University of Hyderabad and University of Kerala) as the between-subject factor.

The main effect of time was significant, $F(1,58) = 6.51, p = .01, \eta^2 = .10$. Participants had smaller conflict effect at T2 ($M = 38.52$ ms, $SE = 1.99$) compared to T1 ($M = 46.28$ ms, $SE = 2.31$) indicating improved conflict resolution abilities over time. The conflict effect was lower for participant from University of Hyderabad ($M = 39.41$ ms, $SE = 2.16$) compared to University of Kerala ($M = 45.40$ ms, $SE = 2.16$) which was indicated by the main effect of group, $F(1,58) = 3.81, p = .05, \eta^2 = .06$. However, the main effect of interlocutor failed to reach significance, $F(2,116) = 1.79, p = .17, \eta^2 = .03$.

The two-way interaction between interlocutor and group was marginally significant, $F(2,116) = 2.55, p = .08, \eta^2 = .04$. For participants from University of Kerala, the conflict effect did not differ between high-L2 proficient ($M = 46.85$ ms, $SE = 2.66$), low-L2 proficient ($M = 46.35$ ms, $SE = 3.10$) or neutral ($M = 42.98$ ms, $SE = 3.00$) interlocutors. However, for participants from University of Hyderabad, the conflict effect differed significantly between high-L2 proficient and low-L2 proficient interlocutors ($p = .005$), with participants having lowest conflict effect in the presence of high-L2 proficient ($M = 34.55$ ms, $SE = 2.66$) compared to low-L2 proficient ($M = 43.67$ ms, $SE = 3.10$) and neutral ($M = 40.01$ ms, $SE = 3.00$) interlocutors. The interaction between time and group [$F(1,58) = 1.48, p = .22, \eta^2 = .02$], as well as the interaction between time and interlocutor [$F(2,116) = 2.08, p = .12, \eta^2 = .03$] were not significant.

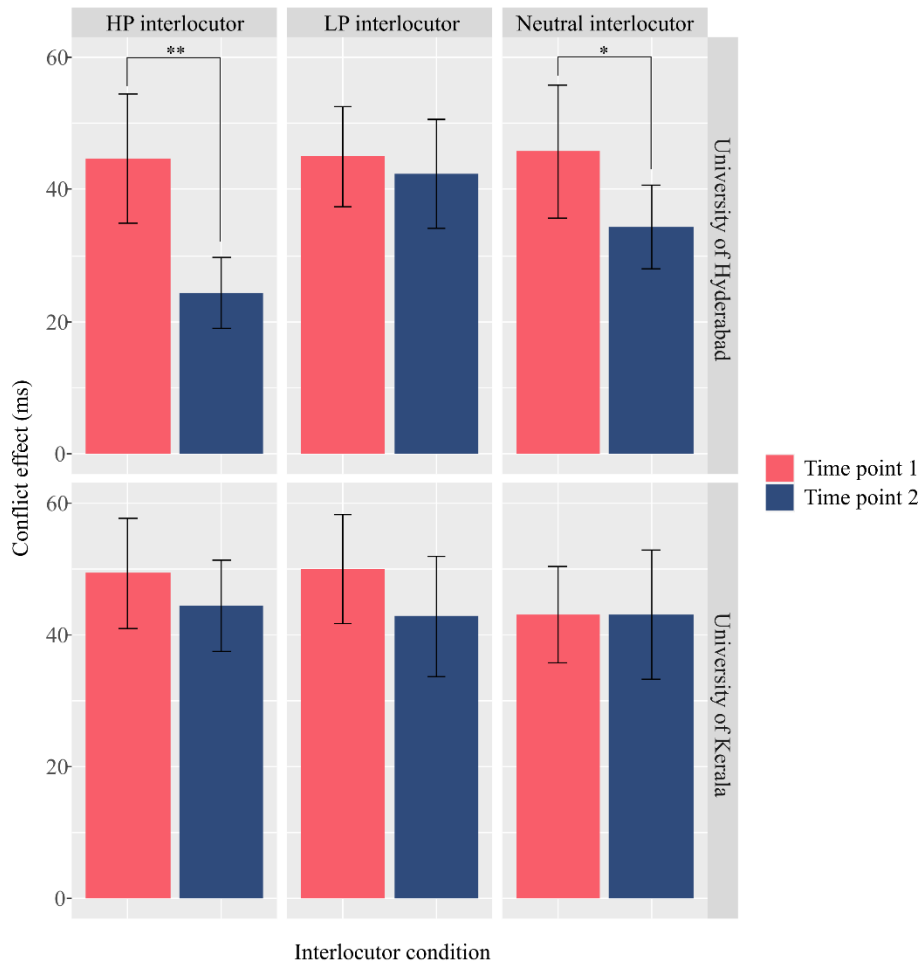


Figure 15. Conflict effect in the presence of high-L2 proficient, low-L2 proficient and neutral interlocutors at T1 and T2 for participants from the University of Hyderabad and the University of Kerala. For participants from the University of Kerala, the conflict effect reduced at T2 in the presence of high-proficient and neutral interlocutors.

The interaction between time, interlocutor and group was significant, $F(2,116) = 3.27$, $p = .04$, $\eta^2 = .05$. The conflict effect of participants from University of Kerala in the presence of high-L2 proficient (T1: $M = 49.32$ ms, $SE = 4.44$; T2: $M = 44.39$ ms, $SE = 3.04$), low-L2 proficient (T1: $M = 49.97$ ms, $SE = 3.86$; T2: $M = 42.74$ ms, $SE = 4.21$) and neutral (T1: $M = 42.98$ ms, $SE = 4.30$;

T2: $M = 42.99$ ms, $SE = 4.02$) interlocutors did not differ at both time points – T1 and T2 (Figure 15). However, in the case of participants from University of Hyderabad, conflict effect was significantly different ($p < .001$) in the presence of high-L2 proficient interlocutor between the two-time points T1 ($M = 44.71$ ms, $SE = 4.44$) and T2 ($M = 24.40$ ms, $SE = 3.04$). Similarly, conflict effect in the presence of neutral interlocutors also differed significantly ($p = .05$) between T1 ($M = 45.75$ ms, $SE = 4.30$) and T2 ($M = 34.26$ ms, $SE = 4.02$). However, the conflict effect in the presence of low-L2 proficient interlocutor (T1: $M = 44.97$ ms, $SE = 3.86$; T2: $M = 42.37$ ms, $SE = 4.21$) did not change over time ($p = .62$).

4.3.3 Error Analysis: Interlocutor. Repeated measures ANOVA was carried out on the percentage of errors with time (T1 and T2), interlocutor (high-L2 proficient, low-L2 proficient and neutral interlocutor) and trial (congruent and incongruent) as within-subject factors and group (University of Kerala and University of Hyderabad) as the between-subject factor.

There was a significant main effect of time, $F(1,58) = 4.62$, $p = .03$, $\eta^2 = .07$. Strikingly, participants made higher errors at T2 ($M = 2.22\%$, $SE = 0.30$) compared to T1 ($M = 1.60\%$, $SE = 0.19$). Participants committed more errors on incongruent trials ($M = 2.75\%$, $SE = 0.29$) compared to congruent trials ($M = 1.07\%$, $SE = 0.15$), $F(1,58) = 73.26$, $p < .001$, $\eta^2 = .55$. The main effect of interlocutor was absent, $F(2,116) = 0.67$, $p = .5$, $\eta^2 = .01$. Also, the main effect of group was absent, $F(1,58) = 1.37$, $p = .24$, $\eta^2 = .02$.

No two-way interactions were significant. That is, the interactions between time and group [$F(1,58) = 2.17$, $p = .14$, $\eta^2 = .03$], interlocutor and group [$F(2,116) = 0.24$, $p = .78$, $\eta^2 = .004$], trial and group [$F(1,58) = 0.32$, $p = .57$, $\eta^2 = .005$], time and interlocutor [$F(2,116) = 0.16$, $p = .84$, $\eta^2 = .003$], time and trial [$F(1,58) = 1.94$, $p = .16$, $\eta^2 = .03$] as well as interlocutor and trial [$F(2,116)$

= 0.87, $p = .41$, $\eta^2 = .01$] failed to reach significance. Hence, further pairwise comparisons were not carried out.

The three-way interaction between time, interlocutor and group was not significant, $F(2,116) = 0.55$, $p = .57$, $\eta^2 = .009$. Likewise, the interactions between time, trial and group [$F(1,58) = 0.04$, $p = .83$, $\eta^2 = .001$], interlocutor, trial and group [$F(2,116) = 0.17$, $p = .84$, $\eta^2 = .003$], and time, interlocutor and trial [$F(2,116) = 0.92$, $p = .40$, $\eta^2 = .01$] were also not significant. The four-way interaction between time, interlocutor, trial and group was also not observed, $F(2,116) = 1.92$, $p = .15$, $\eta^2 = .03$.

4.3.4 Control Experiment. Similar to the main experiment, before carrying out the analysis, all the missing trials, RTs below and above two standard deviations from the mean and incorrect trials were removed. The remaining data were analysed using repeated-measures ANOVA with time (T1, T2), and trial (congruent and incongruent) as within-subject factors and group (University of Hyderabad and University of Kerala) as the between-subject factor.

The participants were faster at T2 ($M = 484.14$ ms, $SE = 6.93$) compared to T1 ($M = 511.47$ ms, $SE = 10.79$) which was indicated by a main effect of time, $F(1,58) = 8.76$, $p = .004$, $\eta^2 = .13$. The reaction time was faster on congruent trials ($M = 472.62$ ms, $SE = 8.11$) compared to incongruent trials ($M = 522.99$ ms, $SE = 7.76$), $F(1,58) = 247.87$, $p < .001$, $\eta^2 = .81$. However, the main effect of group was not significant, $F(1,58) = 0.004$, $p = .94$, $\eta^2 < .001$.

The two-way interaction between time and trial was significant, $F(1,58) = 6.87$, $p = .01$, $\eta^2 = .10$. Participants were faster at T2 ($M = 462.68$ ms, $SE = 7.11$) compared to T1 ($M = 482.57$ ms, $SE = 11.33$) on congruent trials. In similar fashion, participants were faster at T2 ($M = 505.59$ ms, $SE = 7.01$) compared to T1 ($M = 540.38$ ms, $SE = 10.85$) on incongruent trials. The interaction between time and group failed to reach significance, $F(1,58) = 2.72$, $p = .10$, $\eta^2 = .04$. The

interaction between trial and group was significant, $F(1,58) = 3.81, p = .05, \eta^2 = .06$. Participants were faster on congruent trials compared to incongruent trials irrespective of the group. The three-way interaction between time, trial and group was also significant, $F(1,58) = 3.75, p = .05, \eta^2 = .06$. Pairwise comparison indicated that the performance of participants from University of Hyderabad improved significantly at T2 compared to T1 on both congruent ($p = .03$; T1: $M = 490.04$ ms, $SE = 16.08$, T2: $M = 460.41$ ms, $SE = 10.06$) and incongruent trials ($p < .001$; T1: $M = 547.11$ ms, $SE = 15.44$, T2: $M = 491.58$ ms, $SE = 9.64$). However, there was no significant difference in the performance of participants from University of Kerala between T1 and T2 on congruent ($p = .46$; T1: $M = 475.09$ ms, $SE = 16.08$, T2: $M = 464.94$ ms, $SE = 10.06$) as well as incongruent ($p = .30$; T1: $M = 533.65$ ms, $SE = 15.44$, T2: $M = 519.61$ ms, $SE = 9.64$) trials.

4.3.4.1 Conflict effect. Before analysing the data, the conflict effect was calculated by subtracting reaction time on congruent trial from the incongruent trial (that is, RT incongruent – RT congruent). Following this, a repeated measure ANOVA with time (T1, T2) as within-subject factor and group (University of Hyderabad and University of Kerala) as between-subject factor was carried out.

The main effect of time was significant, indicating faster conflict resolution at T2 ($M = 42.91$ ms, $SE = 2.25$) compared to T1 ($M = 57.81$ ms, $SE = 5.61$), $F(1,58) = 6.87, p = .01, \eta^2 = .10$. The two-way interaction between time and group was significant, $F(1,58) = 3.75, p = .05, \eta^2 = .06$. Pairwise comparisons showed reduced conflict effect ($p = .002$) at T2 ($M = 31.16$ ms, $SE = 3.18$) compared to T1 ($M = 57.06$ ms, $SE = 7.94$) for participants from University of Hyderabad. However, there was no difference ($p = .63$) in the conflict effect (T1: $M = 58.55$ ms, $SE = 7.94$; T2: $M = 54.66$ ms, $SE = 3.18$) for participants from University of Kerala. Participants from University of Hyderabad ($M = 44.11$ ms, $SE = 4.52$) had smaller conflict effect compared to

participants from University of Kerala ($M = 56.61$ ms, $SE = 4.52$) indicating a main effect of group, $F(1,58) = 3.81$, $p = .05$, $\eta^2 = .06$.

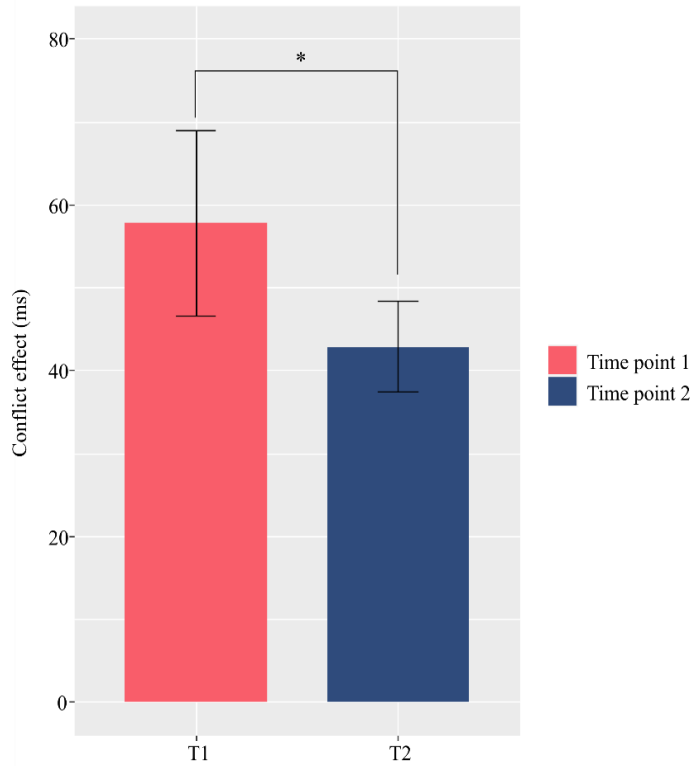


Figure 16. Conflict effect in the control task across the two time points.

4.3.4.2 Error analysis. The percentage of errors the participants made was calculated, and repeated measures ANOVA was carried out on the same with time (T1 and T2) and trial (congruent and incongruent) as within-subject factors and group (University of Hyderabad and University of Kerala) as between-subject factor.

The main effect of time was significant, $F(1,58) = 10.26$, $p = .002$, $\eta^2 = .15$. Similar to the main experiment, participants made more errors at T2 ($M = 2.12\%$, $SE = 0.24$) compared to T1 ($M = 1.28\%$, $SE = 0.17$). The participants made more errors on incongruent trials ($M = 2.74\%$, $SE = 0.28$) compared to congruent trials ($M = 0.67\%$, $SE = 0.12$) which was indicated by a main effect

of trial, $F(1,58) = 56.50, p < .001, \eta^2 = .49$. There was no significant difference between the groups on the percentage of errors, $F(1,58) = 3.22, p = .07, \eta^2 = .05$.

The two-way interaction between time and trial was not significant, $F(1,58) = 3.61, p = .06, \eta^2 = .05$. The interaction between time and group [$F(1,58) = 0.17, p = .67, \eta^2 = .003$] as well as the interaction between trial and group [$F(1,58) = 0.22, p = .63, \eta^2 = .004$] was absent. The three-way interaction between time, trial and group was absent, $F(1,58) = 0.23, p = .62, \eta^2 = .004$.

4.3.5 Correlation. To see if the bilingual language-experience variables correlated with the interlocutor adaptation, the correlation between the different variables at the two time points were separately carried out. The language-experience related variables were percentage of L1 and L2 exposure, self-rate proficiency in L1 and L2, and current exposure to L1 and L2 in various interactional contexts (friends, family, tv/YouTube, radio, reading and self). Age of acquisition of L1 and L2, vocabulary score in both the languages, naming latencies as well as the age of the participants were also considered. The above-mentioned variables were correlated with conflict effect (a measure of inhibitory control/conflict resolution) in the presence of high-L2 proficient, low-L2 proficient and neutral interlocutors as well as the control condition.

At time-point 1, the language-related variables did not predict the performance of the participants on the task. However, at time point 2, the conflict effect in the presence of high-L2 proficient interlocutor correlated negatively with L2 exposure ($\gamma = -.33, p = .009$), interaction with friends in L2 ($\gamma = -.61, p < .001$), exposure to tv/YouTube in L2 ($\gamma = -.24, p = .05$) and self-learning of L2 ($\gamma = -.29, p = .02$); and positively with L1 exposure ($\gamma = .36, p = .003$), interaction with friends in L1 ($\gamma = .46, p < .001$), watching tv/YouTube ($\gamma = .29, p = .02$) and listening to radio ($\gamma = .29, p = .02$) in L1.

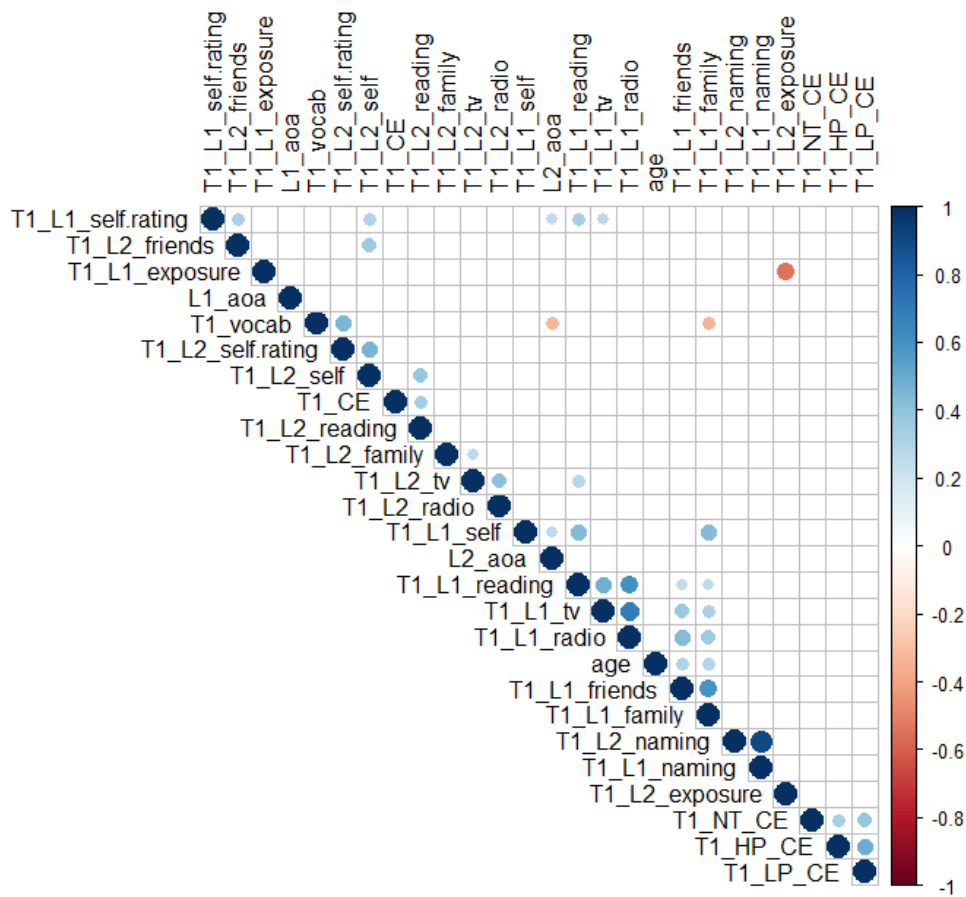


Figure 17. Correlogram depicting the relation between different variables at T1.

Conflict effect in the control condition was negatively correlated with L2 exposure ($\gamma = -.31, p = .01$) and interacting with friends in L2 ($\gamma = -.34, p = .007$); and positively correlated with L1 exposure ($\gamma = .45, p < .001$), interaction with friends in L1 ($\gamma = .50, p < .001$), watching tv/YouTube ($\gamma = .43, p < .001$), and reading ($\gamma = .43, p < .001$) in L1.

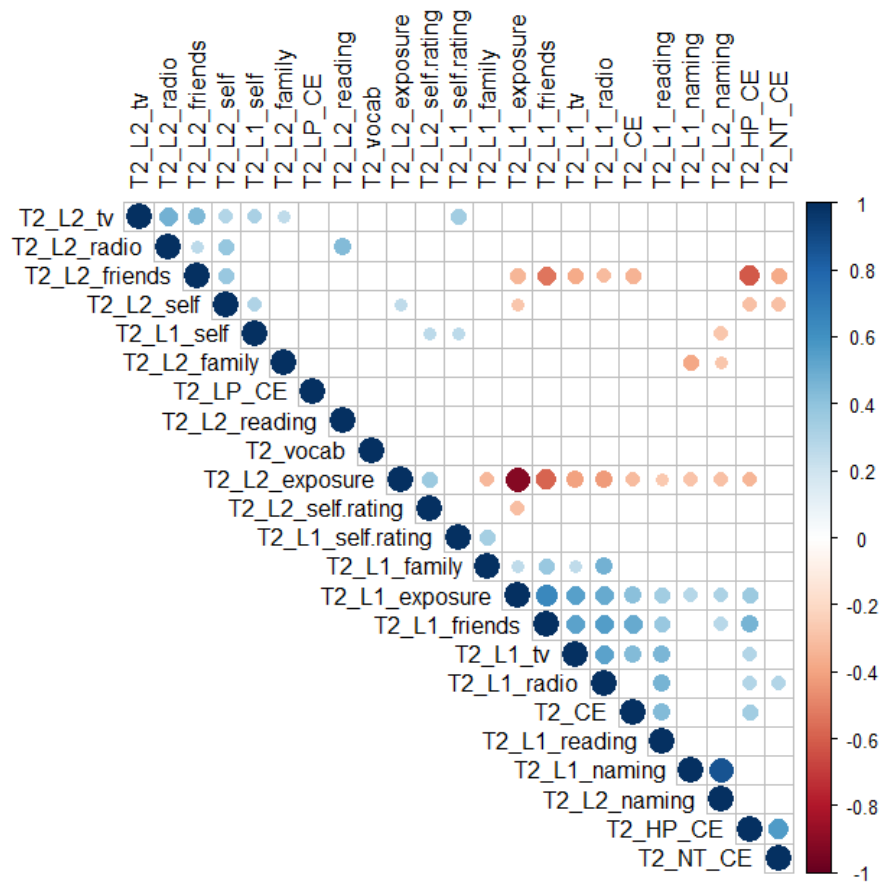


Figure 18. Correlogram depicting the relation between different variables at T2.

4.4 Discussion

The current study explored if immediate real-world interactional context modulates executive control through a longitudinal study. Two groups of Malayalam-English bilinguals from two different interactional contexts – the University of Hyderabad and the University of Kerala – differing in their daily language use and exposure were tested on the Flanker task incorporating three interactional context using interlocutors of varying L2 proficiency at two time points. The

results revealed that the changes in the interactional context modulate the executive control mechanisms, and this depends on the “behavioural ecology of the bilingual speakers” (Green, 2011). This aligns with the adaptive control hypothesis (Green & Abutalebi, 2013) and empirical studies indicating how interactional contexts influences cognitive control mechanisms (Hartanto & Yang, 2020; Rafeekh & Mishra, 2020). The findings obtained from the control task suggest that there is a link between language use and cognitive control, which is important to explain the bilingual advantage hypothesis.

The present study incorporated two methods – the use of task-induced interactional context and the long-term language experience – to examine the relationship between interactional context and executive control in a single experiment. The results from the first approach indicated that participants showed faster conflict resolution in the presence of high-L2 proficient interlocutor, that is, when the task demands were higher. The results are in line with previous evidence, which suggests that increased proficiency in L2 is associated with higher conflict resolution abilities; all the participants in the study were proficient in L2 with their medium of instruction also in L2 (years of education in L2 = 17.52, $SD = 0.49$). This is consistent with the results obtained from Chapter 2 and Chapter 3. The second approach compared participants from two different geographical locations to see the effect of long-term language experience on executive control with respect to different interactional contexts. The results showed that participants from the University of Hyderabad showed smaller conflict effect compared to participants from the University of Kerala ($p = .05$), indicating a difference across both the groups. For participants from the University of Kerala, the conflict effect in the presence of interlocutors did not differ across the two time points. However, the conflict effect was smaller in the presence of high-L2 proficient ($p < .001$) and neutral interlocutor ($p = .05$) at T2 compared to T1 for participants from the

University of Hyderabad. At the University of Hyderabad, individuals engage in L2 more often compared to L1. At T1, the participants had just arrived at the campus (the participants had not spent more than two weeks in Hyderabad at the time of data collection), and hence the use of L2 was limited. Whereas at T2, they had spent more than six months on the campus and hence the exposure to L2 and its use was high. A context where both the languages are used tends to have a facilitative effect on the domain-general control mechanisms and hence can lead to better conflict monitoring and conflict resolution abilities (Jiao et al., 2020). This was observed in the reduced conflict effect at T2 for participants from the University of Hyderabad. Additionally, contexts that demand code-switching also tends to regulate executive control (Adler et al., 2019).

The correlation data throws light on the importance of language use in different domains of life and its contribution to interlocutor adaptation. Since most of the participants stayed in hostels (96.66%), they interacted more with friends compared to family and the outside world. Increased interaction with friends in L2 indicated better conflict resolution in the presence of high-L2 proficient interlocutor. This particular finding is important as it considers the language use of the participants. Also, exposure to tv/YouTube in L2 and self-learning of L2 also predicted enhanced conflict resolution, but only in the presence of high-L2 proficient interlocutor. Previous research has established that proficient bilinguals have better interference and resolution abilities (Singh & Mishra, 2013, 2014). The language-related experience of bilinguals, in addition to second language proficiency, may contribute to this enhanced control.

The results from the control task indicated that participants had smaller conflict effect at T2 compared to T1, and also participants from the University of Hyderabad showed smaller conflict effect compared to participants from the University of Kerala. These findings are consistent with second language immersion and training studies that have shown increased conflict

resolution as a result of increased use and exposure to a second language. The language use and exposure did not differ across the two time points from participants from the University of Kerala, and this reflected on their task performance; no difference in conflict effect was observed across the two time points on the control task. This result is especially significant in contributing to the ‘bilingual advantage debate’. As Paap et al. (2016) suggest, studies should focus on the interactional context and bilingual language-related experience to understand the cognitive consequences of the use of two languages.

The sociolinguistic context of an individual determines the activation of languages and contributes to the proficiency in a particular language (Schrauf, 2009), which in turn influences the domain-general control mechanisms. In addition to the long-term language experience, the context-induced by interlocutors modulated the executive control mechanisms, which reflected on conflict effect measured through the Flanker task. This is the first study to incorporate both approaches within a single task. However, the type of control mechanism employed in different contexts remains unclear. A task like AX-CPT could provide more insights into this matter. Further studies should use different tasks to measure different executive functions, especially to see the influence of interactional context on working memory ability, etc. Also, neurocognitive measures should be taken into consideration as long-term language experience is found to influence neurocognitive structures and domain-general control mechanisms (Abutalebi & Green, 2008, 2016).

In conclusion, the study further reinforces the vital role of language-related experiences on the development and growth of domain-general cognitive control mechanisms. It also shows the importance of considering bilingual experience in research comparing more than one bilingual

group. Interlocutors of varying language proficiencies can impact cognitive control and this, in turn, is dependent on the language experience of the bilinguals.

Chapter 5: Summary and Conclusion

The current thesis aimed at examining the impact of interactional context on executive control and how the adaptation to different contexts varies with respect to “bilingual experience” in Malayalam-English bilinguals. The studies also explored whether the second language proficiency of the participants, as well as language use and exposure, predicted the modulation of executive control depending on the interactional contexts and if this holds true even in the oculomotor domain. To incorporate interactional context within the experiment, bilingual cartoons (referred to as ‘interlocutors’ in the thesis) with varying second language proficiencies were used; and depending on the language use of the interlocutors, three types of interactional context was created. The results from the studies show robust evidence of modulation of executive control by different interactional contexts. Though the study was not designed to examine the controversies regarding the bilingual advantage hypothesis, the findings provide evidence for considering the language-related experience, especially the language use and exposure, while examining the cognitive consequences of bilingualism.

Since different interactional contexts call for different control settings (Green & Abutalebi, 2013), it was assumed that these changes could be captured using a cognitive control task. The thesis places emphasis on the second language proficiency of the interlocutor and tries to see if encountering interlocutors of varying L2 proficiency influences the performance on the control task. Better conflict resolution in the presence of an interlocutor was considered as adapting to the demands of that specific interlocutor. In line with the previous works, the interactional settings of the bilinguals played a role in modulating the executive control measured using cognitive control tasks like Flanker and Stroop (Beatty-Martinez et al., 2019; Bhandari et al., 2020; Hartanto & Yang, 2016, 2020; Wu & Thierry, 2013). However, the results were not consistent across

participants; it was found that high-L2 proficient bilinguals were able to better adapt to the interactional context compared to low-L2 proficient bilinguals. This is the first study to expand the link between interactional context and executive control to the oculomotor domain. The rest of this chapter discusses in detail the results obtained with respect to the literature and the implications of the work, the limitations and future directions.

The first study (Chapter 2) investigated the modulatory role of interactional context on executive control mechanisms as a function of the second language proficiency of the participants. Through a familiarisation phase, participants were first introduced to three types of cartoons – high-L2 proficient, low-L2 proficient and neutral interlocutors. This was followed by an interaction phase in which participants responded to the questions asked by the interlocutors. Participants then had to do the Flanker task in which these interlocutors were incorporated. In the first experiment, high-L2 proficient bilinguals had better conflict resolution and faster RTs in the presence of high-L2 proficient interlocutors. However, low-L2 proficient bilinguals did not show any specific adaptation pattern towards the interlocutors. The high-L2 proficient bilinguals had significantly faster RTs on both congruent and incongruent trials on the control task indicating a global RT advantage (Hilchey & Klein, 2011). However, the Flanker effect did not vary between the two groups of participants. In Experiment 2, the distribution of trials was manipulated to incorporate high and low monitoring conditions in the task. The pattern of results was similar to Experiment 1; high-L2 proficient bilinguals were faster in the presence of high-L2 proficient interlocutor irrespective of the monitoring condition. Interestingly, the conflict effect was lower in the presence of low-L2 proficient interlocutor for low-L2 proficient bilinguals. Results from the control experiment indicated global RT advantage only for high-L2 proficient bilinguals in both high and low monitoring conditions. The percentage of exposure in L2, as well as the proficiency

of the participants, correlated negatively with the task performance in the presence of high-L2 proficient interlocutor. Overall results from this study indicate that different interactional contexts influence cognitive control differently, and second language proficiency, as well as L2 exposure, affects the same.

The second study (Chapter 3) extended the relationship between interactional context and executive control in the oculomotor domain. High-L2 proficient bilinguals completed the oculomotor Stroop task with different interlocutor conditions. It was observed that interlocutors, irrespective of their language proficiency, modulated cognitive control (here, Stroop effect). When task demands are higher, high-L2 proficient bilinguals show better conflict resolution (Bialystok, 2017; Costa et al., 2009; Singh & Mishra, 2013). Since the high-L2 proficient interlocutors use both languages equally, the cognitive demands are higher when encountering them. Results showed that the Stroop effect was much smaller in the presence of high-L2 proficient interlocutor. Participants had smaller saccade latency on incongruent trials than neutral trials, which is a deviation from existing results. However, the current data is not sufficient enough to explain this.

Finally, the third study (Chapter 4) addressed the effects of immediate interactional context on executive control. It also explored how the long-term bilingual experience or the bilingual environment influences interlocutor adaptation and which factors contribute to this. Through a longitudinal study (7 months duration), two groups of participants – University of Hyderabad and University of Kerala – who differed in their language use were compared on a Flanker task. Three interactional contexts were incorporated into the Flanker task to see if the participants were sensitive to the linguistic context and if this, in turn, modulated cognitive control. Participants from the University of Hyderabad had more exposure to the second language and got more opportunity

to use L2, which reflected in the task performance. Overall results indicated that participants performed better at T2 compared to T1. Though the task performance of the two groups did not differ at the first time point (T1), there was a significant difference when tested at the second time point (T2). At T1, participants from the University of Kerala showed better conflict resolution in the presence of neutral interlocutors, which was not expected. But this disappeared at T2, cognitive control employed across different interlocutor condition did not vary. For participants from the University of Hyderabad, the high-L2 proficient interlocutor had more influence on the conflict effect measured using the Flanker task. The results show that monitoring demands imposed by a context can influence cognitive control requirements. Importantly, the performance of the participants correlated negatively with the exposure and use of L2 and positively with the exposure and use of L1. The evidence suggests that the bilingual environment the participant is in modulates cognitive control, which is consistent with the adaptive control hypothesis (Green & Abutalebi, 2013).

Researchers have employed different methods to explore the link between the communicative context of bilingual and linguistic as well as non-linguistic cognitive control. For example, Wu and Thierry (2013) introduced the idea of context by presenting English or Welsh words within the Flanker task. Three interactional contexts were presented – English, Welsh, or a mixed context – and the participants (Welsh-English bilinguals) were asked to ignore these words. They found that even irrelevant context influenced task performance, and participants had better conflict resolution in the mixed language context. Molnar et al. (2015) and Martin et al. (2016) used interlocutors of different linguistic background to see if interlocutor identity influence language prediction and activation through a lexical decision task in Spanish-Basque bilinguals. The interlocutors' language identity was established through a familiarization phase, and they were

presented on every trial before the target stimuli. They found that the context, as well as the proficiency of the participants, influenced task performance. Hartanto and Yang (2016) investigated the role of context on task-switching abilities by categorizing Singapore bilinguals into two groups – single-language and dual-language context – based on their language switching patterns. They found that participants who were in a dual-language context had smaller switch cost in the colour-shape switching task compared to bilinguals in the single-language context. It should be noted that the interactional context considered in this study was a derived variable. Ye, Mo, and Wu (2017) indirectly measured the link between bilingual experience and executive function by asking Chinese-English proficient and non-proficient bilinguals to perform the Flanker task in a single cultural context and a mixed cultural context. The context was manipulated by presenting culture appropriate images – for single context, images representing the Chinese culture was used, whereas, for mixed context, both Chinese and American or British cultural images were equally used. They found that proficient bilinguals had better performance in the mixed context, especially on the incongruent trials; however, the performance of the two groups did not differ in the single cultural context. Kapiley and Mishra (2019) investigated if the language identity of the interlocutor influenced language production in high-L2 proficient Telugu-English bilinguals. They found that participants take into consideration the language proficiency of their interlocutors while interacting with them, which in turn influences their language control demands. Beatty-Martinez et al. (2019) and Ooi et al. (2018) compared bilinguals from different geographical locations who differed in their language use and found that different interactional contexts modulate linguistic and executive control mechanisms differently.

In line with the abovementioned studies, the current thesis incorporated interactional context by integrating interlocutors of different linguistic profile in a non-linguistic control task.

The language identity of the interlocutor was established through a familiarisation phase in which the participants viewed a video of the interlocutors using the two languages. The high-L2 proficient interlocutor represented a context in which demands on the linguistic as well as cognitive systems were high since these interlocutors used both the language equally. The low-L2 proficient interlocutor used mostly L1, and hence the monitoring demands in this context were low. The neutral interlocutor's language identity was unknown to the participants, and it was hypothesised that the cognitive requirements would lay in between. The participants also interacted with the interlocutors (except neutral interlocutors), thereby reinforcing the profiles of the interlocutors. One advantage of inducing artificial interactional context within an experiment is the ability to characterize the interactional context to mimic the real-life scenario. Indian bilinguals within a region often vary as a function of their L2 proficiency. For example, in the local market, you will find interlocutors with high L1 proficiency but low L2 proficiency, whereas in the classroom, interlocutors with high L1 and L2 proficiency are often encountered. Therefore, introducing controlled interlocutors will help explain the control mechanisms involved in such contexts.

Bilinguals need to activate and choose appropriate language while encountering familiar interlocutors, and this calls for both linguistic and executive control mechanisms. The involvement of these two control mechanisms depends on the social context of the bilingual and the demands on the language systems. Hence, the bilingual environment and experience of the participants were also taken into consideration (Chapter 4) while exploring the relationship between interactional context and executive control to account for the complex and myriad cognitive and linguistic experiences of these bilinguals. The present findings indicate that bilinguals indeed modulate their cognitive control demands to meet the requirements of various interactional context, and this, in turn, is influenced by the use and exposure of L2.

Findings from the thesis on the modulatory role of interactional context on executive control remained consistent. Disparate interlocutors often entail distinct cognitive processes. For example, in the presence of high-L2 proficient interlocutors, bilinguals have to process more information due to language switching instances. The frequent encounter of such taxing instances can lead to enhanced executive functions. However, low-L2 proficient interlocutor mostly uses L1, and hence the cognitive demands are low compared to high-L2 proficient interlocutor. Since the presentation of the interlocutors were task-irrelevant, it was assumed that they did not compete directly for cognitive resources required for carrying out the task; rather, they mimicked the real-life situations wherein the participants are required to switch smoothly between two languages. Since task-irrelevant objects influence performance on a cognitive task (Dolk, Hommel, Prinz, & Liepelt, 2013), the presence of interlocutors was presumed to influence executive functioning measured through the task. The presence of high-L2 proficient bilinguals in an interactional context demands higher monitoring since they can navigate between both languages quickly. Therefore, the participants showed better conflict resolution while encountering high-L2 proficient interlocutors, which supports the predictions put forth by the adaptive control hypothesis (Green & Abutalebi, 2013). The cognitive demands imposed by the neutral interlocutors were hypothesized to be higher than the low-L2 proficient interlocutors since they posed more monitoring demands due to unknown language identity. Though the data shows that participants had smaller conflict effect in the presence of neutral interlocutors, this was not consistent across the studies.

Studies examining the impact of second language proficiency on executive functions have shown that higher second language proficiency is connected to better conflict monitoring and resolution, enhanced cognitive control and flexibility (Prior & Macwhinney, 2010; Rafeekh et al.,

2021; Singh et al., 2019; Singh & Mishra, 2012, 2013, 2014; but see Paap et al., 2017). Hence, the involvement of second language proficiency of the bilingual in contextual regulation of control mechanism with respect to interlocutors was also investigated. It was found that high-L2 proficient bilinguals had faster RTs than low-L2 proficient bilinguals across all interlocutor conditions, which aligns with the existing studies. Low-L2 proficient bilinguals showed smaller conflict effect in the presence of low-L2 proficient interlocutors when the task demands were low (Experiment 2 of Chapter 2), which was not expected. The similitude between the language identity of the interlocutor and participants might have contributed to the task performance. At this juncture, more work on the modulatory role of proficiency on interlocutor adaption is required.

A critical variable in all three studies was exposure to L2³ as it predicted the task performance of the participants. The “behavioural ecology of the bilingual speakers” – the manner of language use – affects the control processes (Green, 2011) since diverse environments call for the activation of different control circuits in the brain. In all the studies, higher exposure to the second language explained smaller conflict effect in the presence of high-L2 proficient interlocutor. The self-rated proficiency in second language also correlated with conflict effect in the presence of high-L2 proficient interlocutor; higher the proficiency score, lower the conflict effect. These results align with the previously reported findings showing that bilingual environment (Pot et al., 2018) and the relative frequency of second language use (Heidlmayr et al., 2016) influence inhibitory control mechanisms. Interestingly, the exposure to L2 predicted participants performance on the control task (Chapter 4) at T2, but this relationship was absent at T1. Additionally, the increased “use of L2 with Friends” (friends will act as interlocutors) also

³The language questionnaire measured the percentage of participants’ language use which mainly included speaking, reading and writing which was treated as “Language exposure”.

reduced the conflict effect in the Flanker task (control task – without interlocutors). This result contributes to those studies suggesting that bilingualism confers an advantage in the domain-general executive functioning. Recent advancements in the field of bilingualism have suggested researchers to focus on the variables such as the age of acquisition of the second language, individual differences, interactional context, use of the two languages and switching patterns (Bialystok, 2017; de Bruin, 2019; de Bruin et al., 2015; Verreyt, Woumans, Vandelandotte, Szmalec, & Duyck, 2016). Unfortunately, age of acquisition of L2 did not correlate with task performance in all three studies, which contradicts some of the existing evidence (Gullifer et al., 2018; Pot et al., 2018). More extensive and controlled studies need to be carried out to identify the factors that contribute to advantages on executive functions in bilinguals compared to monolinguals.

Considering the bi/multilingual interactional situation in India, a major limitation of the thesis is the lack of consideration of mixed interactional context where interlocutors of different language proficiencies are encountered at the same time. Bhandari et al. (2020) investigated how Telugu-English bilinguals modulate cognitive control (measured through the attention network task) in the presence of monolingual, bilingual and neutral interlocutors using the Attention Network Task. Interlocutors were presented either in a mixed block or a pure block (only one interlocutor was encountered at a time). They found that high proficient bilinguals had faster RTs than low proficient bilinguals in the mixed block of the executive network; however, this difference disappeared in the pure block. Since pure monolinguals are hard to meet in our context, the studies should focus on the second language proficiency of the interlocutor and adopt this mixed block in experiments to further examine the contextual effects on cognitive processing mechanism. This will explain the type of control mechanism bilinguals employ to tackle their

interlocutors. This should be complemented with experiments exploring the nature of the control mechanism – whether it is reactive or proactive – during social interactions.

Another limitation of the thesis was the focus on only executive control tasks. It would have been more insightful to examine the role of interactional context on other executive functions such as cognitive flexibility and working memory. The experiments (Chapter 2 and Chapter 4) failed to incorporate neutral trials within the task. They often act as the baseline measure. Though neutral trials were introduced in the oculomotor Stroop task (Chapter 3), participants were slowest on neutral trials. Further studies should incorporate this while investigating the same.

All the studies presented in this thesis are behavioural. The work on the bilingual advantage debate has indicated that neurological studies are useful in understanding language processing and its cognitive consequences (Abutalebi & Green, 2008; Declerck, Eben, & Grainger, 2019). The studies mentioned in the thesis do not address this issue; future research should incorporate the association between behavioural results and brain activity while exploring interactional context mediated differences. Rather than carrying out correlations between linguistic and non-linguistic control mechanisms, future studies should incorporate both aspects to the same experiment to see if the source of dynamic modulation of control by interactional context stems from the linguistic or non-linguistic source to see the cross-talk between bilingual language control and domain-general control mechanisms.

In conclusion, the thesis explored if bilinguals are sensitive to their interlocutors of different proficiencies and if this manifests in their cognitive control abilities. The thesis identifies the interplay between interactional context induced by interlocutor proficiency and its influence on executive control. The results also indicate that this association is modulated by the linguistic

environment of the bilinguals as well as their language proficiency. Since proficient bilinguals have superior conflict monitoring and resolution capabilities in challenging situations, they showed reduced conflict effect in situations that called for greater monitoring (the presence of high-L2 proficient interlocutor). The conflict effect varied as a function of interlocutor proficiency, indicating the influence of interactional context on cognitive processing mechanism. Taken together, these studies show that a non-linguistic context can shift one's executive system to an enhanced level, which in turn enhances non-verbal conflict resolution. Future studies should focus on the importance of bilinguals' linguistic experience and their interaction patterns while trying to comprehend the mutual connection between language and cognition and the cognitive advantages of bilingualism.

References

- Abutalebi, J., Annoni, J. M., Zimine, I., Pegna, A. J., Seghier, M. L., Lee-Jahnke, H., ... Khateb, A. (2008). Language control and lexical competition in bilinguals: An event-related fMRI study. *Cerebral Cortex*, 18(7), 1496–1505. <https://doi.org/10.1093/cercor/bhm182>
- Abutalebi, J., & Green, D. W. (2008). Control mechanisms in bilingual language production: Neural evidence from language switching studies. *Language and Cognitive Processes*, 23(4), 557–582. <https://doi.org/10.1080/01690960801920602>
- Abutalebi, J., & Green, D. W. (2016). Neuroimaging of language control in bilinguals: Neural adaptation and reserve. *Bilingualism*, 19(4), 689–698. <https://doi.org/10.1017/S1366728916000225>
- Adler, R. M., Valdés Kroff, J. R., & Novick, J. (2019). *Journal of Experimental Psychology : Learning , Memory , and Cognition Does integrating a code-switch during comprehension engage cognitive control ?*
- Adolphs, R. (2010, March 25). Conceptual Challenges and Directions for Social Neuroscience. *Neuron*, Vol. 65, pp. 752–767. Cell Press. <https://doi.org/10.1016/j.neuron.2010.03.006>
- Allport, A., & Wylie, G. (1999). Task-switching: Positive and negative priming of task-set. In G. W. Humphreys, J. Duncan, & A. Treisman (Eds.), *Attention, space, and action: Studies in cognitive neuroscience* (pp. 273–296). Oxford University Press. Retrieved from <https://psycnet.apa.org/record/2001-16933-015>
- Allport, F. H. (1924). *Social Psychology*. Boston: Houghton Mifflin Company. Retrieved from https://brocku.ca/MeadProject/Allport/1924/1924_toc.html
- Anderson, J. A. E., Chung-Fat-Yim, A., Bellana, B., Luk, G., & Bialystok, E. (2018). Language and Cognitive Control Networks in Bilinguals and Monolinguals. *Neuropsychologia*, 117,

- 352–363. <https://doi.org/10.1016/j.neuropsychologia.2018.06.023>
- Anderson, J. A. E., Mak, L., Keyvani Chahi, A., & Bialystok, E. (2018). The language and social background questionnaire: Assessing degree of bilingualism in a diverse population. *Behavior Research Methods*, 50(1), 250–263. <https://doi.org/10.3758/s13428-017-0867-9>
- Arioli, M., Crespi, C., & Canessa, N. (2018). Social Cognition through the Lens of Cognitive and Clinical Neuroscience. *BioMed Research International*, 2018. <https://doi.org/10.1155/2018/4283427>
- Arnold, J. E., Eisenband, J. G., Brown-Schmidt, S., & Trueswell, J. C. (2000). The rapid use of gender information: Evidence of the time course of pronoun resolution from eyetracking. *Cognition*, 76(1), B13–B26. [https://doi.org/10.1016/S0010-0277\(00\)00073-1](https://doi.org/10.1016/S0010-0277(00)00073-1)
- Aron, A. R., Robbins, T. W., & Poldrack, R. A. (2014). Inhibition and the right inferior frontal cortex: One decade on. *Trends in Cognitive Sciences*, 18(4), 177–185. <https://doi.org/10.1016/j.tics.2013.12.003>
- Atkinson, A. P., Tipples, J., Burt, D. M., & Young, A. W. (2005). Asymmetric interference between sex and emotion in face perception. *Perception and Psychophysics*, 67(7), 1199–1213. <https://doi.org/10.3758/BF03193553>
- Atkinson, M. A., Simpson, A. A., & Cole, G. G. (2018). Visual attention and action: How cueing, direct mapping, and social interactions drive orienting. *Psychonomic Bulletin and Review*, 25(5), 1585–1605. <https://doi.org/10.3758/s13423-017-1354-0>
- Baez, S., García, A. M., & Ibáñez, A. (2016). The Social Context Network Model in Psychiatric and Neurological Diseases. In M. Wöhr & S. Krach (Eds.), *Social Behavior from Rodents to Humans* (pp. 379–396). Springer. https://doi.org/10.1007/7854_2016_443
- Baez, S., García, A. M., & Ibáñez, A. (2018). How Does Social Context Influence Our Brain and

- Behavior? *Frontiers for Young Minds*, 6. <https://doi.org/10.3389/frym.2018.00003>
- Baez, S., Herrera, E., Villarin, L., Theil, D., Gonzalez-Gadea, M. L., Gomez, P., ... Ibáñez, A. (2013). Contextual Social Cognition Impairments in Schizophrenia and Bipolar Disorder. *PLoS ONE*, 8(3), e57664. <https://doi.org/10.1371/journal.pone.0057664>
- Bak, T. H., Long, M. R., Vega-Mendoza, M., & Sorace, A. (2016). Novelty, challenge, and practice: The impact of intensive language learning on attentional functions. *PLoS ONE*, 11(4), 1–11. <https://doi.org/10.1371/journal.pone.0153485>
- Beatty-Martínez, A. L., & Dussias, P. E. (2019). Adaptive control and brain plasticity A. In I. A. Sekerina, L. Spradlin, & V. Valian (Eds.), *Bilingualism, Executive Function, and Beyond. Questions and insights*. John Benjamins Publishing Company. <https://doi.org/10.1075/sibil.57.04bea>
- Beatty-Martínez, A. L., & Dussias, P. E. (2017). Bilingual experience shapes language processing: Evidence from codeswitching. *Journal of Memory and Language*, 95, 173–189. <https://doi.org/10.1016/j.jml.2017.04.002>
- Beatty-Martínez, A. L., Navarro-torres, C. A., Dussias, P. E., Bajo, M. T., Guzzardo Tamargo, R. E., & Kroll, J. F. (2019). Interactional Context Mediates the Consequences of Bilingualism for Language and Cognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, (October). <https://doi.org/10.1037/xlm0000770>
- Bhandari, P., Prasad, S., & Mishra, R. K. (2020). High proficient bilinguals bring in higher executive control when encountering diverse interlocutors. *Journal of Cultural Cognitive Science*, 4(2), 201–215. <https://doi.org/10.1007/s41809-020-00060-7>
- Bhatia, D., Prasad, S. G., Sake, K., & Mishra, R. K. (2017). Task Irrelevant External Cues Can Influence Language Selection in Voluntary Object Naming: Evidence from Hindi-English

- Bilinguals. *PLOS ONE*, 12(1), e0169284. <https://doi.org/10.1371/journal.pone.0169284>
- Bialystok, E. (2015). Bilingualism and the Development of Executive Function: The Role of Attention. *Child Development Perspectives*, 9(2), 117–121.
<https://doi.org/10.1111/cdep.12116>
- Bialystok, E. (2017). The Bilingual Adaptation: How Minds Accommodate Experience. *Psychological Bulletin*, 143(3), 233–262. <https://doi.org/10.1037/bul0000099>
- Bialystok, E., & Barac, R. (2012). Emerging Bilingualism: Dissociating Advantages for Metalinguistic Awareness and Executive Control. *Cognition*, 122(1), 67–73.
<https://doi.org/10.1016/j.cognition.2011.08.003>
- Bialystok, E., Craik, F. I. M., Green, D. W., & Gollan, T. H. (2009). Bilingual minds. *Psychological Science in the Public Interest, Supplement*, 10(3), 89–129.
<https://doi.org/10.1177/1529100610387084>
- Bialystok, E., Craik, F., & Luk, G. (2008). Cognitive Control and Lexical Access in Younger and Older Bilinguals. *Journal of Experimental Psychology: Learning Memory and Cognition*, 34(4), 859–873. <https://doi.org/10.1037/0278-7393.34.4.859>
- Bialystok, E., Klein, R., Craik, F. I. M., & Viswanathan, M. (2004). Bilingualism, aging, and cognitive control: Evidence from the Simon task. *Psychology and Aging*, 19(2), 290–303.
<https://doi.org/10.1037/0882-7974.19.2.290>
- Blanco-Elorrieta, E., & Pylkkänen, L. (2016). Bilingual Language Control in Perception versus Action: MEG Reveals Comprehension Control Mechanisms in Anterior Cingulate Cortex and Domain-General Control of Production in Dorsolateral Prefrontal Cortex. *Journal of Neuroscience*, 36(2), 290–301. <https://doi.org/10.1523/JNEUROSCI.2597-15.2016>
- Blanco-Elorrieta, E., & Pylkkänen, L. (2017). Bilingual Language Switching in the Laboratory

- versus in the Wild: The Spatiotemporal Dynamics of Adaptive Language Control. *Journal of Neuroscience*, 37(37), 9022–9036. <https://doi.org/10.1523/JNEUROSCI.0553-17.2017>
- Blanco-Elorrieta, E., & Pylkkänen, L. (2018). Ecological Validity in Bilingualism Research and the Bilingual Advantage. *Trends in Cognitive Sciences*, 22(12), 1117–1126. <https://doi.org/10.1016/j.tics.2018.10.001>
- Blumenfeld, H. K., & Marian, V. (2013). Parallel language activation and cognitive control during spoken word recognition in bilinguals. *Journal of Cognitive Psychology*, 25(5), 547–567. <https://doi.org/10.1080/20445911.2013.812093>
- Bonfieni, M., Branigan, H. P., Pickering, M. J., & Sorace, A. (2019a). Cognitive control in bilinguals: Effects of language experience and individual variability. *Bilingualism*. <https://doi.org/10.1017/S1366728918001086>
- Bonfieni, M., Branigan, H. P., Pickering, M. J., & Sorace, A. (2019b). Language experience modulates bilingual language control: The effect of proficiency, age of acquisition, and exposure on language switching. *Acta Psychologica*, 193, 160–170. <https://doi.org/10.1016/j.actpsy.2018.11.004>
- Braver, T. S., Reynolds, J. R., & Donaldson, D. I. (2003). Neural mechanisms of transient and sustained cognitive control during task switching. *Neuron*, 39(4), 713–726. [https://doi.org/10.1016/S0896-6273\(03\)00466-5](https://doi.org/10.1016/S0896-6273(03)00466-5)
- Cacioppo, J. T. (2002). Social neuroscience: understanding the pieces fosters understanding the whole and vice versa. *The American Psychologist*, 57(11), 819–831. <https://doi.org/10.1037/0003-066X.57.11.819>
- Cacioppo, J. T., Berntson, G. G., Sheridan, J. F., & McClintock, M. K. (2000). Multilevel integrative analyses of human behavior: Social neuroscience and the complementing nature

- of social and biological approaches. *Psychological Bulletin*, 126(6), 829–843.
<https://doi.org/10.1037/0033-2909.126.6.829>
- Carlson, S. M., & Meltzoff, A. N. (2008). Bilingual experience and executive functioning in young children. *Developmental Science*, 11(2), 282–298. <https://doi.org/10.1111/j.1467-7687.2008.00675.x>
- Caspers, S., Zilles, K., Laird, A. R., & Eickhoff, S. B. (2010). ALE meta-analysis of action observation and imitation in the human brain. *NeuroImage*, 50(3), 1148–1167.
<https://doi.org/10.1016/j.neuroimage.2009.12.112>
- Christoffels, I. K., Firk, C., & Schiller, N. O. (2007). Bilingual language control: An event-related brain potential study. *Brain Research*, 1147(1), 192–208.
<https://doi.org/10.1016/j.brainres.2007.01.137>
- Coderre, E. L., Smith, J. F., Van Heuven, W. J. B., & Horwitz, B. (2016). The Functional Overlap of Executive Control and Language Processing in Bilinguals. *Bilingualism: Language and Cognition*, 19(3), 471–488. <https://doi.org/10.1017/S1366728915000188>
- Colomé, À., & Miozzo, M. (2010). Which Words Are Activated During Bilingual Word Production? *Journal of Experimental Psychology: Learning Memory and Cognition*, 36(1), 96–109. <https://doi.org/10.1037/a0017677>
- Colzato, L. S., Bajo, M. T., van den Wildenberg, W., Paolieri, D., Nieuwenhuis, S., Heij, W. La, & Hommel, B. (2008). How Does Bilingualism Improve Executive Control? A Comparison of Active and Reactive Inhibition Mechanisms. *Journal of Experimental Psychology: Learning Memory and Cognition*, 34(2), 302–312. <https://doi.org/10.1037/0278-7393.34.2.302>
- Costa, A., Hernandez, M., Costa-Faidella, J., & Sebastian-Galles, N. (2009). On the bilingual

- advantage in conflict processing: Now you see it, now you don't. *Cognition*, 113(2), 135–149. <https://doi.org/10.1016/j.cognition.2009.08.001>
- Costa, A., Hernandez, M., & Sebastian-Galles, N. (2008). Bilingualism aids conflict resolution: Evidence from the ANT task. *Cognition*, 106(1), 59–86. <https://doi.org/10.1016/j.cognition.2006.12.013>
- Costa, A., Hernández, M., & Sebastián-Gallés, N. (2008). Bilingualism aids conflict resolution: Evidence from the ANT task. *Cognition*, 106(1), 59–86. <https://doi.org/10.1016/j.cognition.2006.12.013>
- Costa, A., Santesteban, M., & Ivanova, I. (2006). How do highly proficient bilinguals control their lexicalization process? Inhibitory and language-specific selection mechanisms are both functional. *Journal of Experimental Psychology: Learning Memory and Cognition*, 32(5), 1057–1074. <https://doi.org/10.1037/0278-7393.32.5.1057>
- Costall, A., & Leudar, I. (2009). 'Theory of Mind': The Madness in the Method. In I. Leudar & A. Costall (Eds.), *Against Theory of Mind* (pp. 39–55). Palgrave Macmillan. https://doi.org/10.1057/9780230234383_3
- Cox, S. R., Bak, T. H., Allerhand, M., Redmond, P., Starr, J. M., Deary, I. J., & MacPherson, S. E. (2016). Bilingualism, social cognition and executive functions: A tale of chickens and eggs. *Neuropsychologia*, 91, 299–306. <https://doi.org/10.1016/j.neuropsychologia.2016.08.029>
- de Bruin, A. (2019). Not all bilinguals are the same: A call for more detailed assessments and descriptions of bilingual experiences. *Behavioral Sciences*, 9(3). <https://doi.org/10.3390/bs9030033>
- de Bruin, A., Bak, T. K., & Della Sala, S. (2015). Examining the effects of active versus inactive

- bilingualism on executive control in a carefully matched non-immigrant sample. *Journal of Memory and Language*, 85, 15–26. <https://doi.org/10.1016/j.jml.2015.07.001>
- De Jaegher, H., Di Paolo, E., & Gallagher, S. (2010). Can social interaction constitute social cognition? *Trends in Cognitive Sciences*, 14(10), 441–447.
<https://doi.org/10.1016/j.tics.2010.06.009>
- Declerck, M., Eben, C., & Grainger, J. (2019). A different perspective on domain-general language control using the flanker task. *Acta Psychologica*, 198, 102884.
<https://doi.org/10.1016/j.actpsy.2019.102884>
- DeLuca, V., Rothman, J., Bialystok, E., & Pliatsikas, C. (2019). Redefining bilingualism as a spectrum of experiences that differentially affects brain structure and function. *Proceedings of the National Academy of Sciences of the United States of America*, 116(15), 7565–7574.
<https://doi.org/10.1073/pnas.1811513116>
- DeLuca, V., Rothman, J., Bialystok, E., & Pliatsikas, C. (2020). Duration and extent of bilingual experience modulate neurocognitive outcomes. *NeuroImage*, 204, 116222.
<https://doi.org/10.1016/j.neuroimage.2019.116222>
- Deluca, V., Rothman, J., & Pliatsikas, C. (2019). Linguistic immersion and structural effects on the bilingual brain: A longitudinal study. *Bilingualism*, 22(5), 1160–1175.
<https://doi.org/10.1017/S1366728918000883>
- Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, Vol. 64, pp. 135–168. Annual Reviews Inc. <https://doi.org/10.1146/annurev-psych-113011-143750>
- Dijkstra, T. (2005). Bilingual Visual Word Recognition and Lexical Access. In J. F. Kroll & A. M. B. de Groot (Eds.), *Handbook of bilingualism: Psycholinguistic approaches* (pp. 179–201). Oxford University Press. Retrieved from <https://psycnet.apa.org/record/2005-08338->

- Dolk, T., Hommel, B., Prinz, W., & Liepelt, R. (2013). The (Not So) social Simon effect: A referential coding account. *Journal of Experimental Psychology: Human Perception and Performance*, 39(5), 1248–1260. <https://doi.org/10.1037/a0031031>
- Downing, P. E., Jiang, Y., Shuman, M., & Kanwisher, N. (2001). A cortical area selective for visual processing of the human body. *Science*, 293(5539), 2470–2473. <https://doi.org/10.1126/science.1063414>
- Duffy, S. A., Kambe, G., & Rayner, K. (2004). The effect of prior disambiguating context on the comprehension of ambiguous words: Evidence from eye movements. In D. S. Gorfein (Ed.), *On the consequences of meaning selection: Perspectives on resolving lexical ambiguity*. (pp. 27–43). American Psychological Association. <https://doi.org/10.1037/10459-002>
- Ellison, T. M., & Miceli, L. (2017). Language monitoring in bilinguals as a mechanism for rapid lexical divergence. *Language*, 93(2), 255–287. <https://doi.org/10.1353/lan.2017.0014>
- Emmorey, K., Luk, G., Pyers, J. E., & Bialystok, E. (2008). The Source of Enhanced Cognitive Control in Bilinguals: Evidence from Bimodal Bilinguals. *Psychological Science*, 19(12), 1201–1206. <https://doi.org/10.1111/j.1467-9280.2008.02224.x>
- Farhadian, M., Abdullah, R., Mansor, M., Redzuan, M., Gazanizadand, N., & Kumar, V. (2010). Theory of Mind in Bilingual and Monolingual Preschool Children. *Journal of Psychology*, 1(1), 39–46. <https://doi.org/10.1080/09764224.2010.11885444>
- Folk, J. R., & Morris, R. K. (2003). Effects of syntactic category assignment on lexical ambiguity resolution in reading: An eye movement analysis. *Memory and Cognition*, 31(1), 87–99. <https://doi.org/10.3758/BF03196085>
- Forster, K. I., & Forster, J. C. (2003). DMDX: A Windows display program with millisecond

- accuracy. *Behavior Research Methods, Instruments, and Computers*, Vol. 35, pp. 116–124. Psychonomic Society Inc. <https://doi.org/10.3758/BF03195503>
- Foucart, A., Martin, C. D., Moreno, E. M., & Costa, A. (2014). Can Bilinguals See It Coming? Word Anticipation in L2 Sentence Reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 1–9. <https://doi.org/10.1037/a0036756>
- Freeman, J. B., Johnson, K. L., Adams, R. B., & Ambady, N. (2012). The social-sensory interface: category interactions in person perception. *Frontiers in Integrative Neuroscience*, 6(OCTOBER 2012), 1–13. <https://doi.org/10.3389/fnint.2012.00081>
- Frischen, A., Bayliss, A. P., & Tipper, S. P. (2007). Gaze cueing of attention: Visual Attention, social cognition, and individual differences. *Psychological Bulletin*, 133(4), 694–724. <https://doi.org/10.1037/0033-2909.133.4.694>
- Gallo, F., Novitskiy, N., Myachykov, A., & Shtyrov, Y. (2020). Individual Differences In Bilingual Experience Modulate Executive Control Network And Performance: Behavioral And Structural Neuroimaging Evidence. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3519852>
- Gerstadt, C. L., Hong, Y. J., & Diamond, A. (1994). The relationship between cognition and action: performance of children 3 1 2-7 years old on a stroop- like day-night test. *Cognition*, 53(2), 129–153. [https://doi.org/10.1016/0010-0277\(94\)90068-X](https://doi.org/10.1016/0010-0277(94)90068-X)
- Gipson, C. L., Gorman, J. C., & Hessler, E. E. (2016). Top-down (prior knowledge) and bottom-up (perceptual modality) influences on spontaneous interpersonal synchronization. *Nonlinear Dynamics, Psychology, and Life Sciences*, 20(2), 193–222. Retrieved from <https://europepmc.org/article/med/27033133>
- Goetz, P. J. (2003). The effects of bilingualism on theory of mind development. *Bilingualism:*

- Language and Cognition*, 6(1), 1–15. <https://doi.org/10.1017/s1366728903001007>
- Goldfarb, L., & Henik, A. (2007). Evidence for task conflict in the Stroop effect. *Journal of Experimental Psychology: Human Perception and Performance*, 33(5), 1170–1176. <https://doi.org/10.1037/0096-1523.33.5.1170>
- Graham, R., & LaBar, K. S. (2007). Garner interference reveals dependencies between emotional expression and gaze in face perception. *Emotion*, 7(2), 296–313. <https://doi.org/10.1037/1528-3542.7.2.296>
- Green, D. W. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition*, 1(2), 67–81. <https://doi.org/10.1017/s1366728998000133>
- Green, D. W. (2011). Language control in different contexts: The behavioral ecology of bilingual speakers. *Frontiers in Psychology*, 2(MAY), 2009–2012. <https://doi.org/10.3389/fpsyg.2011.00103>
- Green, D. W., & Abutalebi, J. (2013). Language control in bilinguals: The adaptive control hypothesis. *Journal of Cognitive Psychology*, 25(5), 515–530. <https://doi.org/10.1080/20445911.2013.796377>
- Grèzes, J., & Decety, J. (2000). Functional anatomy of execution, mental simulation, observation, and verb generation of actions: A meta-analysis. *Human Brain Mapping*, 12(1), 1–19. [https://doi.org/10.1002/1097-0193\(200101\)12:1<1::AID-HBM10>3.0.CO;2-V](https://doi.org/10.1002/1097-0193(200101)12:1<1::AID-HBM10>3.0.CO;2-V)
- Grosjean, F. (1985). The bilingual as a competent but specific speaker-hearer. *Journal of Multilingual and Multicultural Development*, 6(6), 467–477. <https://doi.org/10.1080/01434632.1985.9994221>
- Grosjean, F. (2001). The Bilingual's Language Modes. In J. L. Nicol (Ed.), *Explaining linguistics. One mind, two languages: Bilingual language processing* (pp. 1–22). Blackwell

- Publishing. Retrieved from <https://psycnet.apa.org/record/2005-03262-001>
- Grosjean, F. (2013). Bilingual and Monolingual Language Modes. In C. A. Chapelle (Ed.), *The Encyclopedia of Applied Linguistics*. <https://doi.org/10.1002/9781405198431.wbeal0090>
- Grundy, J. G., Chung-Fat-Yim, A., Friesen, D. C., Mak, L., & Bialystok, E. (2017). Sequential congruency effects reveal differences in disengagement of attention for monolingual and bilingual young adults. *Cognition*, 163, 42–55.
<https://doi.org/10.1016/j.cognition.2017.02.010>
- Guerin, B. (2010). Social Facilitation. In *Bulletin of Science, Technology & Society*. Cambridge: Cambridge University Press. <https://doi.org/10.1177/027046769401400243>
- Gullifer, J. W., Chai, X. J., Whitford, V., Pivneva, I., Baum, S., Klein, D., & Titone, D. (2018). Bilingual experience and resting-state brain connectivity: Impacts of L2 age of acquisition and social diversity of language use on control networks. *Neuropsychologia*, 117, 123–134.
<https://doi.org/10.1016/j.neuropsychologia.2018.04.037>
- Gullifer, J. W., & Titone, D. (2019). Characterizing the social diversity of bilingualism using language entropy. In *Bilingualism*. <https://doi.org/10.1017/S1366728919000026>
- Guo, T., & Peng, D. (2006). Event-related potential evidence for parallel activation of two languages in bilingual speech production. *NeuroReport*, 17(17), 1757–1760.
<https://doi.org/10.1097/01.wnr.0000246327.89308.a5>
- Hari, R., Henriksson, L., Malinen, S., & Parkkonen, L. (2015, October 7). Centrality of Social Interaction in Human Brain Function. *Neuron*, Vol. 88, pp. 181–193. Cell Press.
<https://doi.org/10.1016/j.neuron.2015.09.022>
- Hartanto, A., & Yang, H. (2016). Disparate bilingual experiences modulate task-switching advantages: A diffusion-model analysis of the effects of interactional context on switch

- costs. *Cognition*, 150, 10–19. <https://doi.org/10.1016/j.cognition.2016.01.016>
- Hartanto, A., & Yang, H. (2020). The role of bilingual interactional contexts in predicting interindividual variability in executive functions: A latent variable analysis. *Journal of Experimental Psychology: General*, 149(4), 609–633. <https://doi.org/10.1037/xge0000672>
- Hartsuiker, R. J. (2015). Visual cues for language selection in bilinguals. In R. K. Mishra, N. Srinivasan, & F. Huettig (Eds.), *Attention and Vision in Language Processing* (pp. 129–145). Springer India. https://doi.org/10.1007/978-81-322-2443-3_8
- Hartsuiker, R. J., & Declerck, M. (2009). Albert Costa y Julio Iglesias move up, but Fidel Castro stays put: Language attraction in bilingual language production. *AMLaP 2009 Conference*. Retrieved from https://scholar.google.com/scholar?cluster=7367404457492180934&hl=en&as_sdt=2005&scioldt=0,5
- Hasselmo, N. (1970). Code-Switching and Modes of Speaking. In G. G. Gilbert (Ed.), *Texas Studies in Bilingualism*. Walter de Gruyter & Co. . <https://doi.org/10.1515/9783110845297.179>
- Heidlmayr, K., Doré-Mazars, K., Aparicio, X., & Isel, F. (2016). Multiple language use influences oculomotor task performance: Neurophysiological evidence of a shared substrate between language and motor control. *PLoS ONE*, 11(11), 1–40. <https://doi.org/10.1371/journal.pone.0165029>
- Hernandez, A. E., Dapretto, M., Mazziotta, J., & Bookheimer, S. (2001). Language switching and language representation in Spanish-English bilinguals: An fMRI study. *NeuroImage*, 14(2), 510–520. <https://doi.org/10.1006/nimg.2001.0810>
- Hilchey, M. D., & Klein, R. M. (2011, August 15). Are there bilingual advantages on

- nonlinguistic interference tasks? Implications for the plasticity of executive control processes. *Psychonomic Bulletin and Review*, Vol. 18, pp. 625–658. Springer.
<https://doi.org/10.3758/s13423-011-0116-7>
- Hodgson, T. L., Parris, B. A., Gregory, N. J., & Jarvis, T. (2009). The saccadic Stroop effect: Evidence for involuntary programming of eye movements by linguistic cues. *Vision Research*, 49(5), 569–574. <https://doi.org/10.1016/j.visres.2009.01.001>
- Huguet, P., Galvaing, M. P., Monteil, J. M., & Dumas, F. (1999). Social presence effects in the Stroop task: Further evidence for an attentional view of social facilitation. *Journal of Personality and Social Psychology*, 77(5), 1011–1025. <https://doi.org/10.1037/0022-3514.77.5.1011>
- Ibañez, A., & Manes, F. (2012). Contextual social cognition and the behavioral variant of frontotemporal dementia. *Neurology*, 78(17), 1354–1362.
<https://doi.org/10.1212/WNL.0b013e3182518375>
- Jiao, L., Grundy, J. G., Liu, C., & Chen, B. (2020). Language context modulates executive control in bilinguals: Evidence from language production. *Neuropsychologia*, 142(19), 107441. <https://doi.org/10.1016/j.neuropsychologia.2020.107441>
- Jiao, L., Liu, C., Liang, L., Plummer, P., Perfetti, C. A., & Chen, B. (2018). The contributions of language control to executive functions: From the perspective of bilingual comprehension. *Quarterly Journal of Experimental Psychology*, 174702181882160. <https://doi.org/10.1177/1747021818821601>
- Jin, Z., Yue, S., Zhang, J., & Li, L. (2017). Task-irrelevant emotional faces impair response adjustments in a double-step saccade task. *Cognition and Emotion*, 0(0), 1–8.
<https://doi.org/10.1080/02699931.2017.1386621>

- Kałamała, P., Szewczyk, J., Chuderski, A., Senderecka, M., & Wodniecka, Z. (2020). Patterns of bilingual language use and response inhibition: A test of the adaptive control hypothesis. *Cognition*, 204(April), 104373. <https://doi.org/10.1016/j.cognition.2020.104373>
- Kang, C., Fu, Y., Wu, J., Ma, F., Lu, C., & Guo, T. (2017). Short-term language switching training tunes the neural correlates of cognitive control in bilingual language production. *Human Brain Mapping*, 38(12), 5859–5870. <https://doi.org/10.1002/hbm.23765>
- Kanwisher, N., McDermott, J., & Chun, M. M. (1997). The fusiform face area: A module in human extrastriate cortex specialized for face perception. *Journal of Neuroscience*, 17(11), 4302–4311. <https://doi.org/10.1523/jneurosci.17-11-04302.1997>
- Kapiley, K., & Mishra, R. K. (2019). What do I choose? Influence of interlocutor awareness on bilingual language choice during voluntary object naming. *Bilingualism*, 22(5), 1029–1051. <https://doi.org/10.1017/S1366728918000731>
- Klin, A. (2000). Attributing social meaning to ambiguous visual stimuli in higher-functioning autism and Asperger syndrome: The Social Attribution Task. *Journal of Child Psychology and Psychiatry*, 41(7), 831–846. <https://doi.org/10.1016/j.bandc.2005.12.016>
- Knudsen, E. I. (2007). Fundamental Components of Attention. *Annual Review of Neuroscience*, 30(1), 57–78. <https://doi.org/10.1146/annurev.neuro.30.051606.094256>
- Landry, S. H., Miller-Loncar, C. L., Smith, K. E., & Swank, P. R. (2002). The role of early parenting in children's development of executive processes. *Developmental Neuropsychology*, 21(1), 15–41. https://doi.org/10.1207/S15326942DN2101_2
- Le Pelley, M., Beesley, T., & Griffiths, O. (2015). Associative Learning and Derived Attention in Humans. In R. A. Murphy & R. C. Honey (Eds.), *The Wiley Handbook on the Cognitive Neuroscience of Learning* (pp. 114–135). Wiley-Blackwell.

<https://doi.org/10.1002/9781118650813.ch6>

Le Pelley, M. E., Pearson, D., Griffiths, O., & Beesley, T. (2015). When goals conflict with values: Counterproductive attentional and oculomotor capture by reward-related stimuli. *Journal of Experimental Psychology: General*, 144(1), 158–171.

<https://doi.org/10.1037/xge0000037>

Lewis, C., & Carpendale, J. I. M. (2009). Introduction: Links between social interaction and executive function. *New Directions for Child and Adolescent Development*, Vol. 2009, pp. 1–15. New Dir Child Adolesc Dev. <https://doi.org/10.1002/cd.232>

Li, Y., Yang, J., Suzanne Scherf, K., & Li, P. (2013). Two faces, two languages: An fMRI study of bilingual picture naming. *Brain and Language*, 127(3), 452–462.

<https://doi.org/10.1016/j.bandl.2013.09.005>

Lindsey, E. W., & Malinda, C. J. (2003). Preschoolers' Emotional Competence: Links to Pretend and Physical Play. *Child Study Journal*, 33(1), 39–52. Retrieved from <https://eric.ed.gov/?id=EJ679720>

Little, W. (2012). *Introduction to Sociology – 2nd Canadian Edition*. OpenStax College. Retrieved from <https://opentextbc.ca/introductiontosociology2ndedition/>

Liu, C., Timmer, K., Jiao, L., Yuan, Y., & Wang, R. (2019). The influence of contextual faces on bilingual language control. *Quarterly Journal of Experimental Psychology*, 72(9), 2313–2327. <https://doi.org/10.1177/1747021819836713>

Liu, D., Wellman, H. M., Tardif, T., & Sabbagh, M. A. (2008). Theory of mind development in Chinese children: A meta-analysis of false-belief understanding across cultures and languages. *Developmental Psychology*, 44(2), 523–531. <https://doi.org/10.1037/0012-1649.44.2.523>

- Ludwig, C. J. H., & Gilchrist, I. D. (2002). Stimulus-driven and goal-driven control over visual selection. *Journal of Experimental Psychology: Human Perception and Performance*, 28(4), 902–912. <https://doi.org/10.1037/0096-1523.28.4.902>
- MacKinnon, D. P., Geiselman, R. E., & Woodward, J. A. (1985). The effects of effort on Stroop interference. *Acta Psychologica*, 58(3), 225–235. [https://doi.org/10.1016/0001-6918\(85\)90022-8](https://doi.org/10.1016/0001-6918(85)90022-8)
- Macrae, C. N., Bodenhausen, G. V., & Milne, A. B. (1995). The dissection of selection in person perception: Inhibitory processes in social stereotyping. *Journal of Personality and Social Psychology*, 69(3), 397–407. <https://doi.org/10.1037//0022-3514.69.3.397>
- Marian, V., Blumenfeld, H. K., & Kaushanskaya, M. (2007). The Language Experience and Proficiency Questionnaire (LEAP-Q): Assessing language profiles in bilinguals and multilinguals. *Journal of Speech, Language, and Hearing Research*, 50(4), 940–967. [https://doi.org/10.1044/1092-4388\(2007/067\)](https://doi.org/10.1044/1092-4388(2007/067))
- Marian, V., & Spivey, M. (2003). Competing activation in bilingual language processing: Within-and between-language competition *. *Bilingualism: Language and Cognition*, 6(2), 97–115. <https://doi.org/10.1017/S1366728903001068>
- Martin, C. D., Molnar, M., & Carreiras, M. (2016). The proactive bilingual brain: Using interlocutor identity to generate predictions for language processing. *Scientific Reports*, 6(1), 1–8. <https://doi.org/10.1038/srep26171>
- McMurray, B., Samelson, V. M., Lee, S. H., & Bruce Tomblin, J. (2010). Individual differences in online spoken word recognition: Implications for SLI. *Cognitive Psychology*, 60(1), 1–39. <https://doi.org/10.1016/j.cogpsych.2009.06.003>
- Meuter, R. F. I., & Allport, A. (1999). *Bilingual Language Switching in Naming: Asymmetrical*

- Costs of Language Selection*. 25–40. Retrieved from <http://www.idealibrary.com>
- Mishra, R. K. (2018). Bilingualism and cognitive control. In R. R. Heredia & A. B. Cieslicka (Eds.), *Springer*. <https://doi.org/10.3389/conf.fpsyg.2016.68.00091>
- Mishra, R. K., Olivers, C. N. L., & Huettig, F. (2013). Spoken language and the decision to move the eyes: To what extent are language-mediated eye movements automatic? *Progress in Brain Research*, 202, 135–149. <https://doi.org/10.1016/B978-0-444-62604-2.00008-3>
- Mishra, R. K., Padmanabhuni, M., Bhandari, P., Viswambharan, S., & Prasad, S. G. (2018). Aging, Neuropsychology, and Cognition A Journal on Normal and Dysfunctional Development Language proficiency does not modulate executive control in older bilinguals. *Aging, Neuropsychology, and Cognition*, 26(6), 920–951. <https://doi.org/10.1080/13825585.2018.1562029>
- Mishra, R. K., Singh, N., Pandey, A., & Huettig, F. (2012). Spoken language-mediated anticipatory eyemovements are modulated by reading ability - Evidence from Indian low and high literates. *Journal of Eye Movement Research*, 5(1). <https://doi.org/10.16910/jemr.5.1.3>
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The Unity and Diversity of Executive Functions and Their Contributions to Complex “Frontal Lobe” Tasks: A Latent Variable Analysis. *Cognitive Psychology*, 41(1), 49–100. <https://doi.org/10.1006/cogp.1999.0734>
- Molnar, M., Ibáñez-Molina, A., & Carreiras, M. (2015). Interlocutor identity affects language activation in bilinguals. *Journal of Memory and Language*, 81, 91–104. <https://doi.org/10.1016/j.jml.2015.01.002>
- Moriguchi, Y. (2014). The early development of executive function and its relation to social

interaction: a brief review. *Frontiers in Psychology*, 5, 388.

<https://doi.org/10.3389/fpsyg.2014.00388>

Moriguchi, Y., Lee, K., & Itakura, S. (2007). Social transmission of disinhibition in young children. *Developmental Science*, 10(4), 481–491. <https://doi.org/10.1111/j.1467-7687.2007.00601.x>

Ooi, S. H., Goh, W. D., Sorace, A., & Bak, T. H. (2018). From Bilingualism to Bilingualisms: Bilingual experience in Edinburgh and Singapore affects attentional control differently. *Bilingualism*, 21(4), 867–879. <https://doi.org/10.1017/S1366728918000020>

Paap, K. R., & Greenberg, Z. I. (2013). There is no coherent evidence for a bilingual advantage in executive processing. *Cognitive Psychology*, 66(2), 232–258. <https://doi.org/10.1016/j.cogpsych.2012.12.002>

Paap, K. R., Johnson, H. A., & Sawi, O. (2015). Bilingual advantages in executive functioning either do not exist or are restricted to very specific and undetermined circumstances. *Cortex*, 69, 265–278. <https://doi.org/10.1016/j.cortex.2015.04.014>

Paap, K. R., Johnson, H. A., & Sawi, O. (2016). Should the search for bilingual advantages in executive functioning continue? In *Cortex* (Vol. 74). Masson SpA. <https://doi.org/10.1016/j.cortex.2015.09.010>

Paap, K. R., Myuz, H. A., Anders, R. T., Bockelman, M. F., Mikulinsky, R., & Sawi, O. M. (2017). No compelling evidence for a bilingual advantage in switching or that frequent language switching reduces switch cost. *Journal of Cognitive Psychology*, 29(2), 89–112. <https://doi.org/10.1080/20445911.2016.1248436>

Pearson, D., Donkin, C., Tran, S. C., Most, S. B., & Le Pelley, M. E. (2015). Cognitive control and counterproductive oculomotor capture by reward-related stimuli. *Visual Cognition*,

- 23(1–2), 41–66. <https://doi.org/10.1080/13506285.2014.994252>
- Pelham, S. D., & Abrams, L. (2013). Cognitive Advantages and Disadvantages in Early and Late Bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. <https://doi.org/10.1037/a0035224>
- Perry, R. E., Braren, S. H., Rincón-Cortés, M., Brandes-Aitken, A. N., Chopra, D., Opendak, M., ... Blair, C. (2019). Enhancing Executive Functions Through Social Interactions: Causal Evidence Using a Cross-Species Model. *Frontiers in Psychology, 10*, 2472. <https://doi.org/10.3389/fpsyg.2019.02472>
- Peterson, J. B., & Flanders, J. L. (2005). Play and the Regulation of Aggression. In R. E. Tremblay, W. W. Hartup, & J. Archer (Eds.), *Developmental origins of aggression* (pp. 133–157). The Guilford Press. Retrieved from <https://psycnet.apa.org/record/2005-09268-007>
- Pfabigan, D. M., Gittenberger, M., & Lamm, C. (2019). Social dimension and complexity differentially influence brain responses during feedback processing. *Social Neuroscience, 14*(1), 26–40. <https://doi.org/10.1080/17470919.2017.1395765>
- Phelps, E. A., O'Connor, K. J., Cunningham, W. A., Funayama, E. S., Gatenby, J. C., Gore, J. C., & Banaji, M. R. (2000). Performance on indirect measures of race evaluation predicts amygdala activation. *Journal of Cognitive Neuroscience, 12*(5), 729–738. <https://doi.org/10.1162/089892900562552>
- Philipp, A. M., & Koch, I. (2009). Inhibition in Language Switching: What Is Inhibited When Switching Between Languages in Naming Tasks? *Journal of Experimental Psychology: Learning Memory and Cognition, 35*(5), 1187–1195. <https://doi.org/10.1037/a0016376>
- Picard, F., & Friston, K. (2014). Predictions, perception, and a sense of self. *Neurology, 83*(12),

1112–1118. <https://doi.org/10.1212/WNL.0000000000000798>

Pivneva, I., Mercier, J., & Titone, D. (2014). Executive control modulates cross-language lexical activation during L2 reading: Evidence from eye movements. *Journal of Experimental Psychology: Learning Memory and Cognition*, 40(3), 787–796.

<https://doi.org/10.1037/a0035583>

Pot, A., Keijzer, M., & de Bot, K. (2018). Intensity of Multilingual Language Use Predicts Cognitive Performance in Some Multilingual Older Adults. *Brain Sciences*, 8(5).

<https://doi.org/10.3390/brainsci8050092>

Prior, A., & Macwhinney, B. (2010). A bilingual advantage in task switching. *Bilingualism*, 13(2), 253–262. <https://doi.org/10.1017/S1366728909990526>

Rafeekh, R., Krishna, P. P., Kapiley, K., & Mishra, R. K. (2021). The effects of short-term L2 training on components of executive control in Indian bilinguals. *Cognitive Processing*, 1. <https://doi.org/10.1007/s10339-021-01014-9>

Rafeekh, R., & Mishra, R. K. (2020). The sensitivity to context modulates executive control: Evidence from Malayalam–English bilinguals. *Bilingualism: Language and Cognition*. <https://doi.org/10.1017/S1366728920000528>

Ramos, S., Fernández García, Y., Antón, E., Casaponsa, A., & Duñabeitia, J. A. (2017). Does learning a language in the elderly enhance switching ability? *Journal of Neurolinguistics*, 43, 39–48. <https://doi.org/10.1016/j.jneuroling.2016.09.001>

Redcay, E., & Warnell, K. R. (2018). A Social-Interactive Neuroscience Approach to Understanding the Developing Brain. In *Advances in Child Development and Behavior* (Vol. 54, pp. 1–44). Academic Press Inc. <https://doi.org/10.1016/bs.acdb.2017.10.001>

Reynaud, A. J., Guedj, C., Hadj-Bouziane, F., Meunier, M., & Monfardini, E. (2015). Social

- Facilitation of Cognition in Rhesus Monkeys: Audience Vs. Coaction. *Frontiers in Behavioral Neuroscience*, 9, 328. <https://doi.org/10.3389/fnbeh.2015.00328>
- Riechelmann, E., Raettig, T., Böckler, A., & Huestegge, L. (2019). Gaze interaction: anticipation-based control of the gaze of others. *Psychological Research*, (0123456789). <https://doi.org/10.1007/s00426-019-01257-4>
- Salvia, E., Harvey, M., Nazarian, B., & Grosbras, M. H. (2020). Social perception drives eye-movement related brain activity: Evidence from pro- and anti-saccades to faces. *Neuropsychologia*, 139(March 2019), 107360. <https://doi.org/10.1016/j.neuropsychologia.2020.107360>
- Schoot, L., Hagoort, P., & Segaert, K. (2019). Stronger syntactic alignment in the presence of an interlocutor. *Frontiers in Psychology*, 10(MAR), 1–9. <https://doi.org/10.3389/fpsyg.2019.00685>
- Schrauf, R. W. (2009). English Use Among Older Bilingual Immigrants in Linguistically Concentrated Neighborhoods: Social Proficiency and Internal Speech as Intracultural Variation. *J Cross Cult Gerontol*, 24, 157–179. <https://doi.org/10.1007/s10823-009-9091-0>
- Schroeder, S. R. (2018). Do Bilinguals Have an Advantage in Theory of Mind? A Meta-Analysis. *Frontiers in Communication*, 3, 36. <https://doi.org/10.3389/fcomm.2018.00036>
- Sinclair, L., & Kunda, Z. (1999). Reactions to a Black professional: Motivated inhibition and activation of conflicting stereotypes. *Journal of Personality and Social Psychology*, 77(5), 885–904. <https://doi.org/10.1037//0022-3514.77.5.885>
- Singh, J. P., & Mishra, R. K. (2016). Effect of bilingualism on anticipatory oculomotor control. *International Journal of Bilingualism*, 20(5), 550–562. <https://doi.org/10.1177/1367006915572398>

- Singh, J. P., Prasad, S., & Mishra, R. K. (2019). Language proficiency in bilinguals enhances action preparedness and control. *Journal of Cultural Cognitive Science*, 3(1), 75–90.
<https://doi.org/10.1007/s41809-019-00030-8>
- Singh, N., & Mishra, R. K. (2012). Does language proficiency modulate oculomotor control? Evidence from Hindi English bilinguals. *Bilingualism*, 15(4), 771–781.
<https://doi.org/10.1017/S1366728912000065>
- Singh, N., & Mishra, R. K. (2013). Second language proficiency modulates conflict-monitoring in an oculomotor Stroop task: evidence from Hindi-English bilinguals. *Frontiers in Psychology*, 4(June). <https://doi.org/10.3389/fpsyg.2013.00322>
- Singh, N., & Mishra, R. K. (2014). The modulatory role of second language proficiency on performance monitoring: Evidence from a saccadic countermanding task in high and low proficient bilinguals. *Frontiers in Psychology*, 5(OCT), 1–14.
<https://doi.org/10.3389/fpsyg.2014.01481>
- Skowron, E. A., Cipriano-Essel, E., Gatzke-Kopp, L. M., Teti, D. M., & Ammerman, R. T. (2014). Early adversity, RSA, and inhibitory control: Evidence of children's neurobiological sensitivity to social context. *Developmental Psychobiology*, 56(5), 964–978. <https://doi.org/10.1002/dev.21175>
- Snodgrass, J. G., & Vanderwart, M. (1980). A standardized set of 260 pictures: Norms for name agreement, image agreement, familiarity, and visual complexity. *Journal of Experimental Psychology: Human Learning and Memory*, 6(2), 174–215. <https://doi.org/10.1037/0278-7393.6.2.174>
- Snyder, J., Prichard, J., Schrepferman, L., Patrick, M. R., & Stoolmiller, M. (2004). Child impulsiveness-inattention, early peer experiences, and the development of early onset

- conduct problems. *Journal of Abnormal Child Psychology*, 32(6), 579–594.
<https://doi.org/10.1023/B:JACP.0000047208.23845.64>
- Surrain, S., & Luk, G. (2019). Describing bilinguals: A systematic review of labels and descriptions used in the literature between 2005-2015. *Bilingualism*, 22(2), 401–415.
<https://doi.org/10.1017/S1366728917000682>
- Tao, L., Marzecová, A., Taft, M., Asanowicz, D., & Wodniecka, Z. (2011). The efficiency of attentional networks in early and late bilinguals: the role of age of acquisition. *Frontiers in Psychology*, 2(JUN), 123. <https://doi.org/10.3389/fpsyg.2011.00123>
- Teubner-Rhodes, S., Bolger, D. J., & Novick, J. M. (2017). Conflict monitoring and detection in the bilingual brain. *Bilingualism: Language and Cognition*, 22(2), 228–252.
<https://doi.org/10.1017/S1366728917000670>
- Theeuwes, J., & Belopolsky, A. V. (2012). Reward grabs the eye: Oculomotor capture by rewarding stimuli. *Vision Research*, 74, 80–85. <https://doi.org/10.1016/j.visres.2012.07.024>
- Thierry, G., & Wu, Y. J. (2007). Brain potentials reveal unconscious translation during foreign-language comprehension. *Proceedings of the National Academy of Sciences of the United States of America*, 104(30), 12530–12535. <https://doi.org/10.1073/pnas.0609927104>
- Thothathiri, M., Rattinger, M., & Trivedi, B. (2017). Cognitive control during sentence generation. *Cognitive Neuroscience*, 8(1), 39–49.
<https://doi.org/10.1080/17588928.2015.1090421>
- Timmer, K., Christoffels, I. K., & Costa, A. (2018). On the flexibility of bilingual language control: The effect of language context. *Bilingualism*, 1–14.
<https://doi.org/10.1017/S1366728918000329>
- Todorov, A., & Uleman, J. S. (2003). The efficiency of binding spontaneous trait inferences to

- actors' faces. *Journal of Experimental Social Psychology*, 39(6), 549–562.
[https://doi.org/10.1016/S0022-1031\(03\)00059-3](https://doi.org/10.1016/S0022-1031(03)00059-3)
- Tricoche, L., Ferrand-Verdejo, J., Pélisson, D., & Meunier, M. (2020). Peer Presence Effects on Eye Movements and Attentional Performance. *Frontiers in Behavioral Neuroscience*, 13(January), 1–13. <https://doi.org/10.3389/fnbeh.2019.00280>
- Triplet, N. (1898). The dynamogenic factors in pacemaking and competition. *The American Journal of Psychology*, 9(4), 507. <https://doi.org/10.2307/1412188>
- Tse, C. S., & Altarriba, J. (2012). The effects of first- and second-language proficiency on conflict resolution and goal maintenance in bilinguals: Evidence from reaction time distributional analyses in a Stroop task. *Bilingualism*, 15(3), 663–676.
<https://doi.org/10.1017/S1366728912000077>
- Van Meel, C. S., & Van Heijningen, C. A. A. (2010). The effect of interpersonal competition on monitoring internal and external error feedback. *Psychophysiology*, 47(2), 213–222.
<https://doi.org/10.1111/j.1469-8986.2009.00944.x>
- Verreyt, N., Woumans, E., Vandelandotte, D., Szmalec, A., & Duyck, W. (2016). The influence of language-switching experience on the bilingual executive control advantage. *Bilingualism: Language and Cognition*, 19(1), 181–190.
<https://doi.org/10.1017/S1366728914000352>
- Vygotsky, L. S. (1980). *Mind in Society: The Development of Higher Psychological Processes*. Cambridge: Harvard University Press. Retrieved from
[https://books.google.co.in/books?hl=en&lr=&id=Irq913lEZ1QC&oi=fnd&pg=PR13&dq=Mind+In+Society:+The+Development+of+Higher+Psychological+Processes&ots=HbBrF3xgti&sig=0-URXi6X3gA_CtcIYoZPfB_R7xI#v=onepage&q=Mind In Society%3A The](https://books.google.co.in/books?hl=en&lr=&id=Irq913lEZ1QC&oi=fnd&pg=PR13&dq=Mind+In+Society:+The+Development+of+Higher+Psychological+Processes&ots=HbBrF3xgti&sig=0-URXi6X3gA_CtcIYoZPfB_R7xI#v=onepage&q=Mind+In+Society%3A+The)

Development of Higher Psychol

- Wei, L. (2006). Bilingualism. In *Encyclopedia of Language & Linguistics* (pp. 1–12). Elsevier Ltd. <https://doi.org/10.1016/B0-08-044854-2/01274-8>
- Weinreich, U. (1966). *Languages in Contact: Findings and Problems*. Mouton. Retrieved from https://books.google.co.in/books/about/Languages_in_Contact.html?id=zx4pnwEACAAJ&redir_esc=y
- Winter, L., & Uleman, J. S. (1984). When are social judgments made? Evidence for the spontaneousness of trait inferences. *Journal of Personality and Social Psychology*, 47(2), 237–252. <https://doi.org/10.1037//0022-3514.47.2.237>
- Woumans, E., Martin, C. D., Bulcke, C. Vanden, Van Assche, E., Costa, A., Hartsuiker, R. J., & Duyck, W. (2015). Can faces prime a language? *Psychological Science*, 26(9), 1343–1352. <https://doi.org/10.1177/0956797615589330>
- Wu, Y. J., Chen, M., Thierry, G., Fu, Y., Wu, J., & Guo, T. (2020). *Inhibitory Control Training Reveals a Common Neurofunctional Basis for Generic Executive Functions and Language Switching in Bilinguals*. 1–33. <https://doi.org/10.21203/rs.3.rs-24811/v1>
- Wu, Y. J., & Thierry, G. (2013). Fast Modulation of Executive Function by Language Context in Bilinguals. *Journal of Neuroscience*, 33(33), 13533–13537. <https://doi.org/10.1523/jneurosci.4760-12.2013>
- Yang, H., Hartanto, A., & Yang, S. (2016a). The complex nature of bilinguals' language usage modulates task-switching outcomes. *Frontiers in Psychology*, 7(APR). <https://doi.org/10.3389/fpsyg.2016.00560>
- Yang, H., Hartanto, A., & Yang, S. (2016b). The importance of bilingual experience in assessing bilingual advantages in executive functions. *Cortex*, 75, 237–240.

<https://doi.org/10.1016/j.cortex.2015.11.018>

Ye, Y., Mo, L., & Wu, Q. (2017). Mixed cultural context brings out bilingual advantage on executive function. *Bilingualism*, 20(4), 844–852.

<https://doi.org/10.1017/S1366728916000481>

Yu, Z., & Schwieter, J. W. (2018). Recognizing the Effects of Language Mode on the Cognitive Advantages of Bilingualism. *Frontiers in Psychology*, 9(MAR), 366.

<https://doi.org/10.3389/fpsyg.2018.00366>

Zhang, S., Morris, M. W., Cheng, C. Y., & Yap, A. J. (2013). Heritage-culture images disrupt immigrants' second-language processing through triggering first-language interference. *Proceedings of the National Academy of Sciences of the United States of America*, 110(28), 11272–11277. <https://doi.org/10.1073/pnas.1304435110>

Appendix A: Interlocutor Images

High-L2 proficient
interlocutors



Low-L2 proficient
interlocutors



Neutral interlocutors



Appendix B: Characteristics of the high-L2 and low-L2 proficient interlocutors

	High-L2 proficient interlocutor		Low-L2 proficient interlocutor	
	Female	Male	Female	Male
Age	26	27	26	26
Age of acquisition of L1	1.5	1.5	1	1.5
Age of acquisition of L2	4	5	9	9
Self-rated proficiency in L1	8.33	8.16	8.83	9
Self-rated proficiency in L2	9.33	9	7.66	7.33
Vocabulary score (L2; WordORnot)	71	69	45	41
Semantic fluency score (L1)	16	15.50	16.5	16.75
Semantic fluency score (L2)	17.75	16.75	13.25	12

Appendix C: Questions used in the interaction phase

1. High-L2 proficient female interlocutor:

1. L1 My name is X*. What is your name?
2. L2 Good to see you. How have you been?
3. L2 How do you find Hyderabad?
4. L1 Do you roam around the city and visit new places during free time?
5. L1 I like the greenery and serene atmosphere of this campus. Do you feel the same?
6. L2 By the way, which course are you pursuing?
7. L1 How are your studies? Are the classes interesting?
8. L2 What are your favourite pastimes?
9. L1 Does the University have Sports day/Arts day?
10. L2 It's been a pleasure to meet you. Have a great day.

2. High-L2 proficient male interlocutor:

1. L1 My name is X*. What is your name?
2. L2 Pleased to meet you. Where are you from?
3. L2 Where do you stay? In hostel or outside the campus?
4. L1 How long have you been here in Hyderabad?
5. L1 How do you go out usually?
6. L2 How do you move around the campus?
7. L2 What are you studying here? Do you find it interesting?
8. L1 What do you do at leisure time?
9. L1 I like the food around this place? Do you?
10. L2 It was nice meeting you. Have a nice day.

3. Low-L2 proficient female interlocutor:

1. L1 My name is X*. What is your name?

2. L1 How long have you been studying here?
3. L1 Do you have so many friends in the campus?
4. L1 Do you have classes during weekends?
5. L2 Are you a hosteler or a day scholar?
6. L1 How does the mess system in the campus works?
7. L1 Do the students here actively engage in campus politics?
8. L2 Do you take part in any sports or games?
9. L1 Do you have a gym in the campus? If so, do female students also avail that facility?
10. L1 I had a good time speaking to you. Thank you.

4. Low-L2 proficient male interlocutor:

1. L1 My name is X*. What is your name?
2. L1 Do you like this campus?
3. L2 How long have you been studying here?
4. L1 How do you spend your weekends?
5. L2 How is the room and mess food?
6. L1 From where all can you buy food in the campus?
7. L1 Is it usually hot here?
8. L1 Have you experienced water scarcity in summer?
9. L1 Can we cook food here? If so, where is the grocery shop?
10. L1 It was my pleasure meeting you.

Appendix D: Questions used in the re-familiarisation phase

1. High-L2 proficient female interlocutor:

1. L1 Is the experiment interesting?
2. L2 What do you feel about what you did so far?
3. L2 Press “space bar” to start

2. High-L2 proficient male interlocutor:

1. L2 How do you find the experiment?
2. L1 What do you feel about what you did so far? Easy or difficult?
3. L2 Press “space bar” to continue

3. Low-L2 proficient female interlocutor:

1. L1 Getting bored?
2. L1 Please continue for some more time. This is getting done in a while
3. L1 The experiment will resume again

4. Low-L2 proficient male interlocutor:

1. L1 Are you feeling sleepy?
2. L1 Please be patient for some more time.
3. L1 The experiment will continue now

Appendix E: Sample Consent Form

Subject ID:

Centre for Neural and Cognitive Sciences

University of Hyderabad

CONSENT FORM

Purpose of the experiment: To see the role of social context on executive control mechanism

Procedure: The experiment will start with a series of tests (picture naming, language questionnaire, online vocabulary test) that will measure your language proficiency (in both Malayalam and English). Following this, the experiment will be conducted in the eye-tracking laboratory. You will be shown a set of animated videos of one minute duration where some cartoons will speak either in English or in Malayalam. It will be followed by an interaction phase where the cartoons one after the other will ask you some questions where you have to respond to it. Subsequently, you have to look at the objects in the screen based on the instructions given to you.

Please note:

- Participation in the study is completely voluntary
- Data will be kept confidential and participant's identity will be protected
- The participation will take approximately one hour
- If you are still interested in participating and assisting with the research project, please complete the consent form below. Keep the top of this form for future reference. You can contact me at 9497648873 if you have questions, comments or concerns now or in the future about your participation in the study

Thank you very much for your time and consideration.

Signed _____

(Researcher)

I, _____, give my consent for the participation in the study conducted by Riya Rafeekh and Prof. Ramesh Kumar Mishra.

I understand that:

- My data will be used for research
- My participation is voluntary
- My information will be kept confidential

I have read the information above and any questions I asked have been answered to my satisfaction.
I give consent for my participation in this study.

Phone number:

Email:

Age:

Signature:

Date:

Witness:

- 1.
- 2.

Appendix F: Language Questionnaire

1. Name:

2. Email address:

3. Mobile:

4. Date:

5. Age:

6. Sex

☐ Male

☐ Female

☐ Other:

7. What is the highest degree of education you have obtained?

☐ Bachelor

☐ Master

☐ PhD

8. Are you pursuing any degree now? If yes, please select the degree.

☐ Bachelor

☐ Master

☐ PhD

☐ Not any

9. Birth Place:

10. Native language/Mother tongue (L1):

11. Name the third language you learnt (L3):

12. Please list all the language you know in the order of dominance:

13. What languages do you usually speak at home?

14. Write down the language in which you received instructions at each level of education:

Primary school (1 to 5):

Secondary school/ High school (6 to 10):

Intermediate school (11 to 12):

College/University:

15. Age at which you:

(Age details of L1)

Began acquiring L1:

Began speaking fluently in L1:

Began reading L1:

16. Please rate your proficiency in L1 on a scale of 1-10 (10 being the highest) in:

Speaking:

Understanding spoken language:

Reading

17. Age at which you:

(Age details of L2- English)

Began acquiring English:

Began speaking fluently in English:

Began reading English:

18. Please rate your level of proficiency in English on a scale of 1-10 (10 being the highest) in:

Speaking:

Understanding spoken language:

Reading:

19. Age at which you:

(Age details of L3)

Began acquiring L3:

Began speaking fluently in L3:

Began reading L3:

20. Please rate your level of proficiency in L3 on a scale of 1-10 (10 being the highest) in:

Speaking:

Understanding spoken language:

Reading:

21. Onset age of bilingual usage:

(At what age do you think you started talking in both languages for communication?)

22. In this section, you have to respond to the statements about language attitude by giving mark from 1 to 6.

a) I feel like myself when I speak in my native language

	1	2	3	4	5	6	
Agree	☐	☐	☐	☐	☐	☐	Disagree

b) I feel like myself when I speak in English

	1	2	3	4	5	6	
Agree	☐	☐	☐	☐	☐	☐	Disagree

c) I prefer speaking in my native language most of the time

	1	2	3	4	5	6	
Agree	☐	☐	☐	☐	☐	☐	Disagree

d) I prefer speaking in English most of the time

	1	2	3	4	5	6	
Agree	☐	☐	☐	☐	☐	☐	Disagree

e) I prefer listening to my native language most of the time

	1	2	3	4	5	6	
Agree	☐	☐	☐	☐	☐	☐	Disagree

f) I prefer listening to English most of the time

	1	2	3	4	5	6	
Agree	☐	☐	☐	☐	☐	☐	Disagree

g) I prefer reading in my native language most of the time

Agree 1 2 3 4 5 6 Disagree
○ ○ ○ ○ ○ ○

h) I prefer reading in English most of the time

Agree 1 2 3 4 5 6 Disagree
○ ○ ○ ○ ○ ○

i) I prefer writing in my native language most of the time

Agree 1 2 3 4 5 6 Disagree
○ ○ ○ ○ ○ ○

j) I prefer writing in English most of the time

Agree 1 2 3 4 5 6 Disagree
○ ○ ○ ○ ○ ○

23. When doing math in your head (such as multiplying 243×5), which language do you calculate the numbers in?

- ☐ Native language
- ☐ English

24. If you had to choose one language for the rest of your life, which language would it be?

- ☐ Native language
- ☐ English

☐ Can't day

25. Please indicate if you are a day scholar.

☐ Yes

☐ No

26. Answer the following questions by giving mark on a scale of 1 to 7.

a) How often are you in a situation in which you switch between the languages – your native language and English?

	1	2	3	4	5	6	7	
Never	☐	☐	☐	☐	☐	☐	☐	Very often

b) When choosing a language to speak with a person who is equally fluent in all your languages, how often would you switch between languages?

	1	2	3	4	5	6	7	
Never	☐	☐	☐	☐	☐	☐	☐	Very often

27. Please list what percentage of the time you are currently, on average, using each language (your percentages should add up to 100)

a) Native language:

b) English:

c) Other (if any) :

Appendix G: Stimuli used in object naming task



Ant/ഉറുമ്പ്



Arrow/അമ്പ്



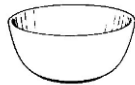
Banana/പഴം



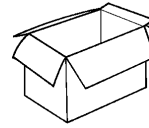
Basket/കുട്ട



Bed/കിടക്ക



Bowl/പാത്രം



Box/പെട്ടി



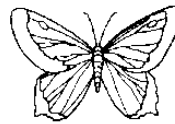
Boy/ആണ்கുട്ടി



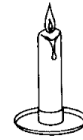
Brinjal/വഴുതന



Buffalo/എരുമ



Butterfly/പൂമ്പാറ്റ



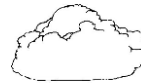
Candle/മെഴുകുതിരി



Cat/പുച്ച



Chilli/മുളക്



Cloud/മേഘം



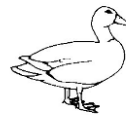
Coconut/തേങ്ങ



Crab/ഞണ്ട്



Dog/പട്ടി



Duck/താറാവ്



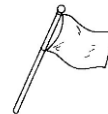
Eye/കണ്ണ്



Finger/വിരല്



Fish/മീൻ



Flag/കൊടി



Flower/പൂവ്



Frog/തവള



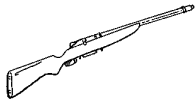
Girl/പെൺകുട്ടി



Goat/ആട്



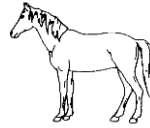
Grapes/മുന്തിരി



Gun/തോക്ക്



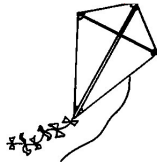
Hat/തൊപ്പി



Horse/കുതിര



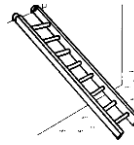
King/രാജാവ്



Kite/പട്ടം



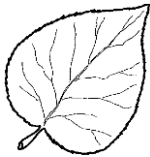
Knife/കത്തി



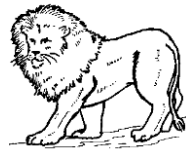
Ladder/ഏണി



Ladies finger/വെണ്ടക്ക



Leaf/ഇല



Lion/സിംഹം



Lips/ചുണ്ടു



Lizard/പല്ലി



Lotus/താമര



Mango/മാങ്ങ



Mask/മുഖം മുടി



Mirror/കണ്ണാടി



Monkey/കുരങ്ങൻ



Moon/ചന്ദ്രൻ



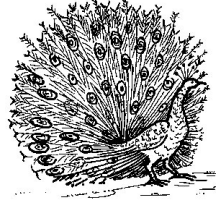
Mosquito/കൊതുക്



Nose/മുക്ക്



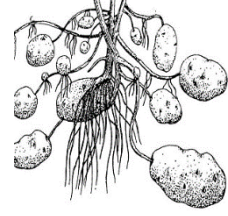
Onion/ഉള്ളി



Peacock/മയിൽ



Pig/പന്നി



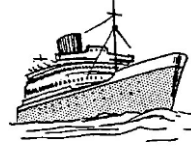
Potato/ഉരുളക്കിഴങ്ങ്



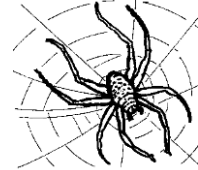
Queen/രാജ്ഞി



Rabbit/മുയൽ



Ship/കപ്പൽ



Spider/ചിലന്തി



Star/നക്ഷത്രം



Tiger/കടുവ



Tomato/തക്കാളി



Tree/മരം

Appendix H: Presentations related to thesis

Rafeekh, R., & Mishra, R. K. (Nov. 2018). The Interlocutors' L2 Proficiency modulates Conflict Monitoring: Evidence from Flanker Task. *International Symposium on Bilingualism*, Birla Institute of Technology and Science, Pilani – Goa Campus, India (Oral)

Rafeekh, R., & Mishra, R. K. (Sept. 2019). Does interactional context modulate conflict monitoring: Evidence from Stroop task. *Architectures and Mechanisms for Language Processing (AMLaP)*, Moscow, Russia (Poster)