

Bilingualism and Executive Function

An Interdisciplinary Approach

Date: 18-19 May 2015, Monday 9:00 - 19:15 and Tuesday 9:00 - 20:00.

Place: CUNY Graduate Center (365 5th Ave, New York City)

The Graduate Center of the City University of New York, with the generous support of the National Science Foundation, is pleased to announce a two-day workshop on bilingualism and executive function. The workshop's 5 panels will each feature two invited speakers and a discussant. The participants' areas of expertise include cognitive psychology, linguistics, aging, and neuropsychology, bringing an interdisciplinary perspective to the question of how bilingualism is related to executive function.

The Workshop will immediately precede the International Symposium on Bilingualism-10 at Rutgers University (ISB-10, 20-24 May 2015).

Attendance is free thanks to generous support from the National Science Foundation.

Bilingualism speakers

Thomas Bak (U of Edinburgh), Albert Costa (U Pompeu Fabra), Harold Clashen and João Veríssimo (U of Potsdam), Judith Kroll (Penn State), Antonella Sorace (U of Edinburgh)

Executive function speakers

Naomi Friedman (U of Colorado), Raymond Klein (Dalhousie), Klara Marton (CUNY), Yaakov Stern (Columbia U), Laura Zahodne (Columbia U)

Discussants

Jubin Abutelabi (U Vita-Salute San Raffaele), Virginia Mueller Gathercole (Florida International U), Lynn Hasher (U of Toronto), Randall W. Engle (Georgia Tech), Virginia Valian (CUNY)

Summary and Synthesis

Ellen Bialystok (York University)

Organizing Committee

Irina A. Sekerina, Virginia Valian, Stephen Boatright, Lauren Spradlin (CUNY Grad Center)

Web site: <http://bef2015.commons.gc.cuny.edu/>

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Workshop on Bilingualism and Executive Function: An Interdisciplinary Approach

18 & 19 May 2015
Proshansky Auditorium
CUNY Graduate Center
365 Fifth Avenue
New York, NY 10016



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About the Workshop

Workshop on Bilingualism and Executive Function: An Interdisciplinary Approach

The [Graduate Center of the City University of New York](#), with the generous support of the [National Science Foundation](#), is pleased to invite you to a **two-day workshop** on bilingualism and executive function, to be held on

18-19 May 2015 (Monday and Tuesday) at the CUNY Graduate Center

Location: Proshansky Auditorium (downstairs)

Registration and breakfast on start at 9:00 in Room C202 (downstairs) on both days.

The Workshop will immediately precede the [International Symposium on Bilingualism-10](#) at Rutgers University (ISB-10, 20-24 May 2015).

The workshop has an interdisciplinary focus as it will bring together experts from different disciplines broadly divided into two areas, bilingualism and executive function. The disciplines include cognitive psychology, linguistics, aging, and neuropsychology. Each of the 5 panels will feature two invited speakers, who are leading experts, and a discussant. Together the participants will discuss mechanisms and approaches that will connect bilingualism and executive function. To facilitate and inspire the interdisciplinary exchange of ideas among researchers and students from different backgrounds, and to promote collaborative research projects in the future, Day 1 features a poster session (17:15-19:15), with 44 posters on bilingualism and executive function.

Organizers

Irina A. Sekerina, chair of the Organizing Committee. Dr. Sekerina has experience with conference and event organization, including participation in organization of the Annual CUNY Human Sentence Processing Conference (when it convenes in New York City), now in its 28th year. In 2006, together with Co-PIs Eva Fernández and Harald Clahsen, she organized and conducted the two-day Workshop on *On-Line Methods in Children's Language Processing* funded by the NSF Developmental and Learning Sciences. The Workshop was held at the CUNY Graduate Center in March 2006, with 120 attendees and resulted in publication of the volume based on the talks given during the Workshop (Sekerina et al., 2008). Dr. Sekerina has worked on heritage language bilingualism for the past ten years and conducts eye-tracking experiments with bilingual adults.

Virginia Valian, co-chair of the Organizing Committee. Dr. Valian is Distinguished Professor of Psychology at Hunter College, and Distinguished Professor of Psychology, Linguistics, and Speech-Language-Hearing Sciences at the Graduate Center. Dr. Valian performs research on first and second language acquisition and bilingualism, investigating children's early knowledge of syntax and second language learners' and bilinguals' knowledge of grammatical principles. Dr. Valian was a presenter at the Bilingual Advantage in Children and Adults: Types of Inhibition Control at the 9th International Symposium on Bilingualism in Singapore described above. In her study (Humphrey & Valian, 2012), no bilingual advantage was found in RTs for incongruent-congruent trials for either the Simon or Flanker tasks, demonstrating that being bilingual does not necessarily provide advantages to young adults in cognitive processing.

Lauren Spradlin, member of the Organizing Committee, invited speakers' liaison. Lauren is a Ph.D. student in Linguistics at the CUNY Graduate Center.

Stephen Boatright, member of the Organizing Committee, webmaster and IT fellow. Stephen is a Ph.D. candidate in Earth and Environmental Sciences at the CUNY Graduate Center.

Program

Day 1 – Monday, May 18, 2015

09:00-9:40 Registration and breakfast

Panel 1 Introduction to bilingualism and executive function

09:40-09:50 Opening remarks: Loraine K. Obler (CUNY Graduate Center)

09:50-10:40 Judith Kroll: *Bilingualism Transforms Language, Cognition, and the Brain*

10:40-11:30 Naomi Friedman: *What Is (Are) Executive Function(s)? Insights From Individual Differences Research*

11:30-11:50 Discussant: Virginia Valian

11:50-12:30 Open discussion (moderated)

Lunch

12:30-14:00

Panel 2 Methodological issues

14:00-14:50 Harald Clahsen and Joao Verissimo: *Investigating Grammatical Processing in Bilinguals: The Case of Morphological Priming*

14:50-15:40 Jennifer Manly and Laura Zahodne: *Methodological Issues in Research on Bilingualism, Cognitive Aging, and Cognitive Reserve*

15:40-16:00 Discussant: Randall W. Engle

16:00-16:40 Open discussion (moderated)

Coffee break

16:40-17:10

Poster session and refreshments

17:15-19:15

Day 2 – Tuesday, May 19, 2014

09:00-9:30 Registration and breakfast

Panel 3 Bilingualism and cognition in young adults

09:30-10:20 Albert Costa: *On the Cross Talk Between Bilingual Language Control and Executive Control*

10:20-11:10 Raymond Klein: *What Cognitive Processes are Likely to be Exercised by Bilingualism and Does This Exercise Lead to Extra-linguistic Cognitive Benefits?*

11:10-11:30 Discussant: Theo Marinis

11:30-12:10 Open discussion (moderated)

Lunch

12:10-13:20

Panel 4 Bilingualism, linguistic structure, and executive function in children

13:20-14:10 Klara Marton: *Do Bilingual Children Perform More Efficiently in Different Experimental Tasks Than Their Monolingual Peers?*

14:10-15:00 Antonella Sorace: *Referring Expressions and Executive Functions in Child and Adult Bilinguals*

15:00-15:20 Discussant: Virginia Mueller Gathercole

15:20-16:00 Open discussion (moderated)

Coffee break

16:00-16:30

Panel 5 Bilingualism and cognitive reserve in older adults

16:30-17:20 Thomas Bak: *The Influence of Bilingualism on Cognitive Aging and Dementia: Competence, Communication and Context*

17:20-18:10 Yaakov Stern: *What Is Reserve and How Do We Get It?*

18:10-18:30 Discussant: Lynn Hasher

18:30-19:10 Open discussion (moderated)

Summary and Synthesis

19:10-20:00 Speaker: Ellen Bialystok

Invited Speakers



Ellen Bialystok (York University, Canada)

Distinguished Research Professor of Psychology at York University and Associate Scientist at the Rotman Research Institute of the Baycrest Centre for Geriatric Care. She obtained her Ph.D. in 1976 from the University of Toronto specializing in cognitive and language development in children. Her current research focuses on the effect of bilingualism on language and cognition across the lifespan showing modification in cognitive systems from this experience. Her research uses both behavioral and neuroimaging methods and examines participants who are children, younger or older adults, as well as patients. She has published extensively in the form of books, scientific articles, and book chapters. She is a fellow of the Royal Society of Canada and among her awards are the Canadian Society for Brain Behaviour and Cognitive Science Hebb Award (2011), Killam Prize for the Social Sciences (2010), York University President's Research Award of Merit (2009), Donald T. Stuss Award for Research Excellence at the Baycrest Geriatric Centre (2005), Dean's Award for Outstanding Research (2002), Killam Research Fellowship (2001), and the Walter Gordon Research Fellowship (1999). [Further information](#).



Jubin Abutalebi (University Vita-Salute San Raffaele, Italy)

Associate Professor of Neuropsychology in the Department of Psychology, expert in the neuroimaging and the cerebral basis of language control in bilinguals. He specializes in the cerebral basis of language control in bilinguals. He will bring a welcome contribution on the neuroscience of bilingualism. He is co-Editor of *Bilingualism: Language and Cognition*.



Thomas H. Bak (University of Edinburgh, UK)

Researcher at the School of Philosophy, Psychology, and Language Sciences; expert on the relationship between language, cognition, and motor function. An article of which he is a co-author (Alladi et al., 2013) has attracted attention as the first large-scale study of positive effects of bilingualism on delaying onset of dementia independent of education, occupation, and literacy.



Harald Clahsen (University of Potsdam)

Co-director of the Potsdam Research Institute for Multilingualism. Dr. Clahsen's research has focused on language disorders and grammatical processing in native speakers and language learners using psycholinguistic experimentation. In addition to multilingualism, grammatical processing, and language disorders, his research interests include theories of morphology and syntax. He is a Fellow of the British Academy and a Member of the Academy of Europe.



Albert Costa (University Pompeu Fabra, Spain)

Research Professor in Social & Behavioural Sciences; expert in bilingual speech production and neuroimaging techniques. In 2012-2013, Dr. Costa's group published 20 articles on the relation between bilingualism and executive control in young adults and patients with Alzheimer's disease.



Randall W. Engle (Georgia Tech)

Professor of Psychology and Interim Director, Center for Advanced Brain Imaging. Dr. Engle's research focuses on memory capacity and attention control. He has argued that individual differences in the construct measured as working memory capacity reflects differences in the ability to control attention to internally generated and externally elicited representations and that differences in ability are important components of general fluid intelligence (Engle & Kane, 2004).



Naomi Friedman (University of Colorado)

Assistant Professor in the Department of Psychology and Neuroscience and Institute for Behavioral Genetics. Dr. Friedman is an expert on individual differences in executive functions, including their phenotypic and genetic relations to other cognitive abilities, and an author of several influential articles on executive function (e.g., Miyake & Friedman, 2012).



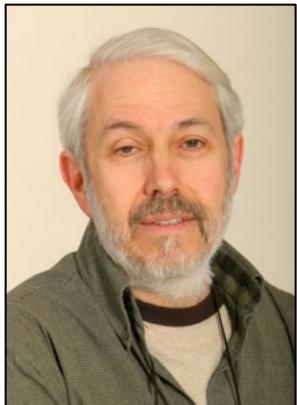
Virginia Mueller Gathercole (Florida International University)

Professor of Linguistics, expert on monolingual and bilingual language acquisition in relation to semantics, morphosyntax, and assessment. Her work also addresses issues concerning the relationship between language and cognition. She specializes in the acquisition of English, Spanish, and Welsh in Spanish-English and Welsh-English bilinguals.



Lynn Hasher (University of Toronto, Canada)

Professor of Psychology and Senior Scientist at the Rotman Research Institute at Baycrest Centre. Dr. Hasher is an expert in gerontology research with a focus of the role that basic attentional processes play in the ability to understand language and remember events. Dr. Hasher's recent publications address distraction, cognitive control, and suppression of interference in aging.



Raymond Klein (Dalhousie University, Canada)

University Research Professor at the Department of Psychology and Neuroscience; expert in human performance and applied cognitive psychology; published the first paper (Hilchey & Klein, 2011) that found inconsistent evidence for the relationship between bilingualism and cognitive control.



Judith F. Kroll (Penn State University)

Distinguished Professor of Psychology, Linguistics, and Women's Studies; Director of the Center for Language Science; editor of several books on bilingualism; PI on the NSF PIRE grant that has been developing an international network of training in bilingualism.



Klara Marton (CUNY Graduate Center)

Professor in Speech-Language-Hearing Sciences; expert on changes in language and cognition across lifetime, and interaction between inhibition, and attentional control. Dr. Marton and her colleagues (Marton et al., 2013) demonstrated that balanced but not L2 learning bilingual children outperformed monolinguals, but the effect was modulated by language proficiency.



Antonella Sorace (University of Edinburgh, UK)

Professor of Developmental Linguistics at the School of Philosophy, Psychology, and Language Sciences; expert on the reciprocal effects of bilingualism and general cognition; PI on numerous U.K. and European grants; the founder and Director of Bilingualism Matters, a network that promotes benefits of bilingualism for children.



Yaakov Stern (Columbia University)

Professor of Neuropsychology, Department of Neurology and Taub Institute for Research on Alzheimer's Disease and the Aging Brain; the author of the cognitive reserve theory in aging research (Stern, 2009). Dr. Stern's team explores the factors that make older adults more resistant to cognitive decline as well as cognitive, behavioral, and neurological features that slow down progression of Alzheimer's disease.



João Veríssimo (University of Lisbon, University of Potsdam)

Postdoctoral researcher at the University of Potsdam. Dr. Veríssimo's research interests include lexical representation and morphological processing in native and non-native speakers. The larger theoretical questions that form the background for this work concern the debates between symbolic and associative models of language and cognition, the psychological reality of grammar, and the contrast between nativist and empiricist approaches to origins of linguistic knowledge.



Laura Zahodne (Columbia University)

Associate Research Scientist at the Department of Neurology. Dr. Zahodne's interests include psychosocial factors in aging and neurodegenerative diseases, psychosocial factors and racial/ethnic diversity in cognitive aging, and statistical modeling of symptom trajectories.



Theo Marinis (University of Reading)

Professor of Multilingualism and Language Development. His research focuses on first and second language acquisition in typically developing children, children with SLI and children with ASD. Using a range of off-line and on-line experiments his research addresses the development of language processing across populations and the relationship between language and cognition.

ABSTRACTS FROM INVITED SPEAKERS

Panel 1 Introduction to bilingualism and executive function

Bilingualism transforms language, cognition, and the brain

Judith F. Kroll (The Pennsylvania State University)

There is a great deal of mythology about bilingualism. Some worry that children exposed to more than one language early in life will become confused and fail to become a fluent speaker of either language. Others think that language mixing produces disfluencies that indicate underlying pathology. Current studies show that these beliefs are simply wrong. Using two languages actively does indeed change each of a bilingual's two languages, but in ways that hold consequences for the mind and the brain that are largely positive. The continual availability of both languages requires the bilingual to become a mental juggler, learning to negotiate the competition arising from the language not in use to selectively focus on the intended language. Bilingualism may impose unique demands on cognition but the successful resolution of those demands may translate into benefits for learning and memory more generally. Bilingualism creates an openness to new language learning and sharpens the ability to resolve cognitive conflict. These consequences are complex because the contexts in which multiple languages are learned and used differ across groups of bilingual speakers. In this talk I focus on the way that bilingualism transforms language use and, in doing so, changes the mind and the brain.

What Is (Are) Executive Function(s)? Insights From Individual Differences Research

Naomi Friedman (University of Colorado)

Executive functions are high-level cognitive processes that enable control over thoughts and actions through their regulation of lower-level processes. They are central to many areas of psychology, including research on psychopathology, development, aging, and bilingualism, to name a few. Yet there is still considerable variability in how researchers measure these abilities, and how they conceptualize the cognitive and neural mechanisms that underlie individual differences in performance on executive tasks. Part of this variability stems from the fact that executive functioning is not a single ability, but rather is a family of interrelated but separable abilities. I will present an overview of one well-replicated model, the unity/diversity model, which describes the relationships among three of the most frequently studied executive functions: response inhibition, working memory updating, and task switching. The model is so named because these abilities show some unity, in that a common factor influences individual differences in all three, but also show diversity, in that there are also specific factors that influence individual differences in working memory updating and task switching. After discussing the genetic and environmental influences on these unity and diversity components, and what they may be measuring in terms of cognitive mechanisms, I will discuss implications and recommendations for incorporating them into bilingualism research.

Panel 2 Methodological issues

Investigating grammatical processing in bilinguals: The case of morphological priming

João Veríssimo & Harald Clahsen (Potsdam Research Institute for Multilingualism, University of Potsdam, Germany)

Much previous work on the advantages and disadvantages of bilingualism has focused on vocabulary or the processing of simple words. From a linguistic perspective, however, vocabulary is a rather peripheral aspect of the knowledge of language, and claims about the effects of bilingualism that are based on tasks that tap only into lexical aspects may not necessarily hold for bilingual language processing as a whole.

In this talk we will discuss methods for investigating grammatical processing in bilinguals, focusing on the use of morphological priming studies. We will present a methodological approach that relies on (i) linguistic (in our case, morphological) theory for the construction of experimental materials, (ii) a design that allows for direct (within-experiment, within-participant and within-item) comparisons of the critical conditions, and (iii) data analysis techniques that make both linear and non-linear gradient effects visible. We believe that these considerations are not only relevant for morphological priming experiments, but for studying bilingual language processing more generally.

We illustrate our approach using new data from a large-scale study with more than 90 bilingual participants from the Turkish/German community in Berlin investigating age effects in bilingual grammatical processing. The main discovery of this study was a selective age-of-acquisition (AoA) effect for grammatical processing abilities that (by using statistical modeling techniques) can be precisely delimited to a particular age range. Our participants all learnt Turkish from birth and German at different ages, spanning an AoA range from birth to about 35 years of age. We tested them on both inflectional and derivational priming in German. While derivational priming was found not to be affected by AoA and was present across the whole AoA range, inflectional priming showed a gradual AoA-related decline, but only from the ages of 5-6 onwards. Under the assumption that inflection is largely grammatical in nature (in that it simply spells out morphosyntactic features) whereas derivation is lexically-based (in that it creates new words), our results suggest that the critical period for language acquisition might be restricted to grammar, rather than applying to language as a whole. We will discuss the implications of this finding for bilingualism research, including the role of executive function and other non-linguistic factors in bilingual language processing.

Methodological Issues in Research on Bilingualism, Cognitive Aging, and Cognitive Reserve

Laura Zahodne and Jennifer Manly (Columbia University)

Studies of the relationship between bilingualism and dementia have yielded discrepant results. This talk will explore four methodological issues that may help to explain these discrepancies, clarify our understanding of the relationship between bilingualism and cognitive function in older

adults, and guide future research studies of bilingualism and cognitive reserve. First, designs to distinguish causation from association in studies of bilingualism and dementia risk will be discussed. Second, the critical step of distinguishing cognitive level from cognitive change, and interpreting cross-sectional versus longitudinal or incidence studies, will be discussed. Many variables, such as general intellectual ability, socioeconomic status and life experiences, are difficult to disentangle from bilingualism and could also influence cognitive aging trajectories and risk for dementia. These confounds are more problematic in studies based in memory disorders clinics than in community-based studies of older adults. Therefore, the third methodological issue discussed will be how results change when we are better able to isolate and quantify the independent effect of bilingualism on executive function, cognitive decline or dementia incidence. Historical changes in immigration policies and conditions in the native country may be powerful tools to understand the conditions and experiences that travel along with bilingualism and how they relate to cognitive aging. Fourth, the potential advantages of assessing bilingualism skills on a continuum for studies of cognitive reserve and cognitive aging trajectories will be discussed.

Panel 3 Bilingualism and cognition in young adults

On the cross talk between bilingual language control and executive control

Albert Costa (Pompeu Fabra University, Spain)

Models of bilingual language control often hypothesized certain overlap with domain-general executive control mechanisms. However, the specific mechanisms that are common to these two cognitive domains are still not known. In this talk, I review several studies that have aimed at exploring this relationship. These studies involve a wide range of techniques and populations from brain damage individuals to healthy young adult participants. I will argue that the current data is a bit too heterogeneous to argue for a large overlap between bilingual language control and domain-general executive control mechanisms

What cognitive processes are likely to be exercised by bilingualism and does this exercise lead to extra-linguistic cognitive benefits?

Raymond M. Klein (Dalhousie University, Canada)

The various situations encountered by bilingual individuals are considered in light of the cognitive processes that these situations might uniquely exercise. With these in hand we will consider whether this exercise is unique to bilingualism, and whether this exercise results in cognitive benefits that extend beyond the practiced (linguistic for bilingualism) realm. Although the focus will be on the performance of young adults, some consideration will be given to the experiences of young children and the performance of older adults.

Panel 4 Bilingualism, linguistic structure, and executive function in children

Do bilingual children perform more efficiently in different experimental tasks than their monolingual peers?

Klara Marton (CUNY Graduate Center)

Studies on executive functions in bilingual children show mixed findings. Some authors report no group difference between bilingual and monolingual children in executive functions, such as attention control (e.g., Antón et al., 2014), whereas others show superior performance in bilingual children compared to their monolingual peers on the same tasks (e.g., Yang, Yang, & Lust, 2011). What are the sources of these contradictory findings? Several contributing factors have been identified in the bilingual literature. The role of the following factors will be discussed in this presentation: 1. individual language proficiency; 2. language context (societal level); 3. cultural background; 4. overall speed of processing. Based on our own research findings, we will show how the above factors interact with implicit learning, performance monitoring, and interference control in school-age children.

Referring expressions and executive functions in child and adult bilinguals

Antonella Sorace (University of Edinburgh)

Reference tracking requires the language user to both infer appropriate pronoun-referent mappings and dynamically update the discourse model following a change of referent status. Recent research on the so-called ‘syntax-pragmatics interface’ (e.g. Sorace & Serratrice 2009; Sorace 2011; 2011; Chamorro, Sorace & Sturt 2015) shows that pronouns and other referring expressions requiring efficient updating of context-dependent information (a) develop late in bilingual children; (b) remain variable even in highly proficient second language speakers, and (c) become unstable in speakers experiencing native language attrition from a second language. In contrast, more narrowly linguistic structure types that are less dependent on the integration of unpredictable contextual information are more stable in all three bilingual populations. I will explore a possible account of these phenomena based on effects of the bilingual experience on executive functions and how these effects may in turn interact with bilingual language processing in specific ways.

Panel 5 Bilingualism and cognitive reserve in older adults

The influence of bilingualism on cognitive aging and dementia: competence, communication and context

Thomas H. Bak (University of Edinburgh, Scotland)

The question whether bilingualism can influence cognitive functions in later life and even delay the onset of dementia has generated recently considerable controversy. I will argue that different disciplines are likely to approach this question from different perspectives. The main interest of much of the linguistic and psycholinguistic research on bilingualism has been on language knowledge (competence) and on what is often perceived as the “classical” case of bilingualism: early, simultaneous acquisition of two or more languages and a perfect command of them. In contrast, I focus on non-balanced and non-perfect bilingualism, acquired in late childhood and adulthood and emphasize the importance of language use (communication), including its social context. I will propose that such an approach is likely to bring research on bilingualism and cognitive aging closer to the big questions of cognitive reserve.

What Is Reserve and How Do We Get It?

Yaakov Stern (Columbia University)

The concept of reserve has been put forward to account for individual differences in susceptibility to age-related brain changes and pathologic changes, such as those that occur in Alzheimer’s disease. The concept of cognitive reserve suggests that the brain actively attempts to cope with brain damage by using pre-existing cognitive processing approaches or by enlisting compensatory approaches. This talk will review the theory underlying the concept of reserve, and ideas of brain reserve, cognitive reserve and brain maintenance; and epidemiologic evidence for the various lifestyle factors that might contribute to reserve.

POSTERS

1. Structural and Functional Differences between Monolingual and Bilingual Young Adults

Ashley Chung-Fat-Yim (York University), Matthias Berkes (York University), Laura Mesite (Harvard Graduate School of Education), Buddhika Bellana (Baycrest Rotman Research Institute), Gigi Luk (Harvard Graduate School of Education), and Ellen Bialystok (York University)22

2. Multilingualism and cognitive reserve: Evidence from cortical thickness and tissue density

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Kelly A. Vaughn (University of Houston), Aurora I. Ramos-Nuñez (University of Houston), Maya R. Greene (University of Houston), David Vasquez (University of California-Riverside), Adam Felton (University of California-Riverside), Christine Chiarello (University of California-Riverside), & Arturo E. Hernandez (University of Houston)27

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Kenneth Paap (SFSU), Morgan Bockelman (SFSU), Hunter Johnson (SFSU), Eugene Eusebio (SFSU), Sarah Wagner (SFSU), Angel Avalos (SFSU), & Oliver Sawi (University of Connecticut)31

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Chantel S. Prat, Brianna L. Yamasaki, Jose M. Ceballos & Roy Seo (Department of Psychology & Institute for Learning and Brain Sciences, University of Washington)33

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Nathalie Gosselin (University of Montreal; International Laboratory of Brain, Music, and Sound Research -BRAMS; Centre for Research on Brain, Language and Music - CRBLM), Ellen Bialystok (York University), Mihaela Felezeu (BRAMS), & Isabelle Peretz (University of Montreal; BRAMS; CRBLM) 35

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POSTER ABSTRACTS

1. Structural and Functional Differences between Monolingual and Bilingual Young Adults

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Bilingualism; Task switching; fMRI; White matter; TBSS

Previous research has reported behavioral differences between monolingual and bilingual participants in executive control but the brain structures underlying those differences remain largely unknown. Neuroimaging studies have found overlapping circuits for linguistic and nonlinguistic control in bilinguals, but no study to date has examined this in both monolingual and bilingual participants. Hence, we compared behavioral performance, functional connectivity, and brain structures of young adults who were unbalanced but proficient bilinguals and monolinguals who had minimal use of a second language on a verbal and nonverbal switching task in fMRI. Fourteen monolingual and 17 English-French bilingual young adults participated. Groups differed in French proficiency, (Bilingual = 90.2%, Monolingual = 19.8%, $t = 18.72$, $p < .001$) and French usage (Bilingual = 30.9%, Monolingual = 0.40%, $t = 6.69$, $p < .001$). Behavioral results showed equivalent group performance on the nonverbal task but slower performance by bilinguals in the verbal task. Analysis of DTI data showed that bilinguals had higher fractional anisotropy (FA) than monolinguals in association tracts in the left hemisphere, specifically in the superior longitudinal fasciculus, inferior longitudinal fasciculus and inferior fronto-occipital fasciculus (corrected $p < .05$). No area showed higher FA in monolinguals than bilinguals. The higher FA values for bilinguals in these regions are similar to regions found in studies with children[1,2], young adults[3], and older adults[4]. Functional seed partial least squares revealed that monolinguals and bilinguals had different functional connectivity with left temporal regions when engaging in verbal switching, but similar networks when the two groups were engaging in nonverbal switching. These results contribute to our understanding of the brain basis of performance differences shown between monolinguals and bilinguals.

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2. Multilingualism and cognitive reserve: Evidence from cortical thickness and tissue density

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Cognitive reserve; Alzheimer disease; mild cognitive impairment; MRI; cortical thickness; tissue density

According to the cognitive reserve (CR) hypothesis [1] certain lifestyle factors (e.g., physical activity, level of education) may mediate the relationship between degree of brain pathology and clinical manifestation of damage. Recent studies hypothesize that bilingualism may contribute to CR and protect against the onset of dementia [e.g., 2]. The current study intends to contribute to the small body of CR literature examining differences between the brains of monolingual and bilingual older adults and Alzheimer disease patients (e.g., [3,4]).

MRI scans were obtained from ninety-four patients of the Memory Clinic of McGill University at the Jewish General Hospital. Of this group, 68 patients were diagnosed with MCI (34 monolingual, 34 multilingual), and 26 as AD (13 monolingual, 13 multilingual) at the time of their scan. Monolingual participants spoke only one language. Multilingualism was defined according to the criterion set out by Bialystok and colleagues [5] for bilingualism (majority of life regularly using at least two languages). We did not control specifically for the age at which the second language was learned. Within each diagnosis group, patients were matched across language groups on age at time of scan, education, and symptom severity (Mini Mental Status Examination).

For both cortical thickness (Ct) and voxel-based morphometry (VBM) analyses, the dependent variable (vertex-level cortical thickness, voxel-level tissue density) was regressed onto age, Language group (monolingual or multilingual) and Diagnosis group (MCI or AD). Regions of interest were defined based on relevant literature, namely 1) those associated with differences between monolinguals and multilinguals, and 2) those typically associated with AD pathology in its early stages.

Uncorrected regression analyses demonstrate that multilinguals have thicker cortex in areas related to bilingualism (the right inferior frontal gyrus, right rostral middle temporal gyrus, left medial superior frontal gyrus, left rostral inferior temporal gyrus, left inferior parietal cortex, and the right ventromedial prefrontal cortex); none of these areas showed an effect of Diagnosis group. Areas associated with language processing and comprehension (right and left supramarginal gyri, left ventral inferior temporal gyrus) and with AD-pathology (left and right rhinal sulci, left and right caudal parahippocampal gyri) showed an interaction effect, with multilingual MCI showing thicker cortex than monolingual MCI patients; however, this language group advantage was lost when comparing the AD patients. These results suggest that multilingual AD and MCI patients show evidence of cognitive reserve in brain areas related to bilingualism, but that only those earlier in the disease process (MCI patients) continue to show an advantage in areas related to the disease pathology.

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3. Executive Function and Second Language Phonological Processing

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Executive function; fMRI; L1-L2 processing; Speech Perception; Spanish English

This fMRI study investigated neural activity evoked by L2 speech syllables in brain regions of executive function typically recruited by bilinguals in cognitive control tasks. The main areas examined were the bilateral anterior cingulate, bilateral supplementary motor area, bilateral inferior frontal gyrus, and bilateral middle frontal gyrus. Based on the degree of discrepancy between L1 and L2 proficiency scores, twenty-nine children classified as balanced (smaller discrepancy) or unbalanced (larger discrepancy) dual language learners were matched for age, socioeducational background, years of education in L2, and L2 age of acquisition. Children passively listened to L2 syllables while a muted film was presented. The results showed that unbalanced learners had increased activity in multiple frontal regions bilaterally relative to balanced learners. Balanced learners showed activity in a region of the right temporal lobe. The results suggest that unbalanced learners engage regions of executive function to support the processing of L2 speech perception.

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4. Cortical thickness in the cognitive control network, task switching, and bilingualism

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Cortical thickness; task switching; bilingual; inferior parietal lobule

Previous research involving patients with brain damage, children with ADHD, aging adults, Alzheimer's patients, and normal monolingual children and adults suggests that cortical thickness in certain regions of the brain, specifically the dorsolateral prefrontal cortex, anterior cingulate cortex, inferior parietal lobule, and inferior frontal gyrus, is related to cognitive control abilities. In general, greater cortical thickness in these regions is associated with better cognitive control, and lesser cortical thickness is associated with poorer cognitive control. Surprisingly, researchers have not yet examined this relationship within the bilingual population, although bilinguals may have enhanced cognitive control abilities. Additionally, previous research suggests that greater grey matter density in one of these regions, the inferior parietal lobule, is greater for bilinguals than monolinguals, and is related to earlier age of second language acquisition, higher second language proficiency, more language exposure, and better overall language skills (Abutalebi, Canini, Della Rosa, Green, & Weekes, 2015; Della Rosa et al., 2013; Mechelli et al., 2004). Therefore, in order to fully understand the relationship between cortical thickness and cognitive control, it is important to examine the relationship between cortical thickness in the aforementioned regions and performance by bilinguals on a cognitive control task.

This study measured cognitive control using a non-verbal switching task in which participants switched between sorting images by color and sorting images by shape as indicated by a symbolic cue presented randomly throughout the task. Switch costs were calculated for the difference in response time and accuracy for the trial immediately following the switch cue or non-switch cue. Cue costs were calculated for the difference in response time and accuracy for the trial immediately following the cue and a later trial. Results indicate that, in this bilingual sample, cortical thickness is unrelated to reaction time costs for both switch and cue, but cortical thickness of the left inferior parietal lobule correlates with accuracy costs for both switch and cue. These findings shed light on the relationship between cognitive control and language in the brain.

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5. Individual differences in proactive and reactive control processes in bilinguals

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Bilingualism; Bilingual advantage; Cognitive control; Executive control; Code-switching; Event-related brain potentials (ERP); Individual differences

Evidence suggests that bilinguals exhibit superior cognitive control compared to monolinguals by using a flexible combination of proactive processes (monitoring for relevant cues) and reactive processes (inhibiting irrelevant information) to cope with interference from the non-target language¹. This flexibility may be related to individual differences in language-switching behaviours, bilingual proficiency, age of acquisition of the second language (L2), or general executive functioning.

We used event-related brain potentials (ERPs) to examine proactive and reactive control processes in 15 young adult bilinguals (English-French or French-English; mean age = 24; mean self-rated proficiency: L1 = 4.84/5; L2 = 3.8/5) during the AX-CPT task. Participants were presented with the following cue-target letter pairs: A-X, A-Y, B-X, or B-Y (where B and Y are any letter other than A or X). The task was to press the “yes” key to an X target only if preceded by an A cue; all other targets should elicit a “no” response. There was a 750 millisecond interval between cue offset and target onset. We varied the global context of each block (70% A-X, 70% A-Y, 70% B-X), thus altering the degree to which proactive processes could be used to guide performance.

We hypothesized that participants would respond faster and more accurately to A-X pairs compared to A-Y pairs in the A-X-70% block due to the facilitating effect of the global block context (i.e., respond “yes” 70% of the time). In contrast, participants should respond slower and less accurately on A-X pairs compared to A-Y pairs in the A-Y-70% block. In terms of the electrophysiological data, cue-locked ERPs should reflect proactive processes whereas target-locked ERPs should primarily reflect reactive processes. Of particular interest is the N2 ERP component, a negative-going component that peaks 200-350 msec after the onset of a stimulus and is thought to be a marker of conflict detection². We observed a larger target-locked N2 on A-Y trials compared to A-X trials in the AX-70% block. We hypothesize that this is due to the conflict between 1) the task set preparation as a function of both the cue and global context of the block (i.e., prepare “yes” response), and 2) the nature of the target (i.e., withhold “yes” response). In contrast, we did not observe a significant target-locked N2 on A-Y trials in the A-Y-70% block because the prepared “no” response initiated by the cue is congruent with the information subsequently given by the target.

We will report the extent to which these behavioural and ERP effects are modulated by individual differences in language-switching behaviours, proficiency, age of acquisition of L2, and general executive functioning.

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6. Domain-general and language-related inhibition: What L2 comprehension can tell us about executive function skill in bilinguals

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Inhibitory control; L2 comprehension; Letter fluency; ERPs

Bilingual experience has been shown to have an impact on executive function skill across the lifespan. A majority of the research on this topic, however, focuses on the relationship between language production and performance on non-linguistic control tasks. As such, very little is known about how these reported changes in cognitive control ability might influence other aspects of language use, such as reading comprehension. By utilizing an aspect of reading comprehension that has been shown to rely on executive function skill (i.e., recovery from disconfirmed predictions), our aim was to investigate how those control processes that have been implicated as critical for bilingual language processing might support online language use.

In a series of studies, we asked participants to read sentences in the L2 while their EEG was recorded. ERPs were time-locked to target words that were highly expected or unexpected, based on prior context. Performance on a domain-general inhibitory control task significantly predicted modulation of processing costs related to having a lexical prediction disconfirmed (i.e., a reduction in the late frontal positivity for unexpected target words). This effect was found for both monolinguals and bilinguals, in the L1 and L2, and for bilinguals in different immersion contexts, suggesting that the recruitment of domain-general inhibitory control mechanisms during reading is not restricted only to native readers.

Based on this finding, a remaining question was whether this recruitment of domain-general inhibition is in any way related to the types of language-related inhibition effects typically reported for bilingual language production. Therefore, in a follow-up study, we used a blocked letter fluency task to test the degree to which a group of previously tested bilingual participants were capable of disinhibiting their more dominant, native language. In this task, participants were asked to produce words that began with particular letters (e.g., F, A, S). Previous work has shown that producing first in the L2 and then in the L1, and having to produce words beginning with the same letters across languages, is most likely to induce costs related to difficulty with dis-inhibiting the L1.

Our results indicated a strong relationship between domain-general and language-related inhibition. Bilinguals with better domain-general control tended to produce more words overall in the L1 block, suggesting better skill in dis-inhibiting the L1. In addition, cognate status of the words produced in the L1, as well as the degree of orthographic overlap between that word and its L2 translation equivalent, was also important. Overall, then, we show that bilinguals, who utilize domain-general control during L2 comprehension to greater success, are also more capable of flexibly switching languages, providing much stronger evidence for the claim that bilingual language experience has a widespread effect on executive function skill.

7. No bilingual advantages across five switching tasks

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Bilingualism; Switching; Execution Functions; Verbal Fluency

Two hundred SFSU students (55% bilingual) completed three standard switching tasks: color-shape, letter-number, and living-size. We replicated Friedman, et al.'s [1] report of significant correlations between the switching costs derived from each task, thus verifying that the three tasks show convergent validity as measures of switching ability. The substantial level of convergent validity felicitously contrasts with the dismal levels of convergent validity for common measures of inhibitory control [2]. This sets the stage for a strong and compelling test for bilingual advantages in executive functioning (EF) as advocated by Paap and Greenberg [3] in that multiple measures of the same component of EF (switching in this case) can be derived for both language groups. If the results are consistent across the tasks this severely attenuates the chances that they are task specific. There were no differences between the groups of bilinguals and monolinguals in any of the three tasks for either mixing costs (mean RT on the repeat trials of the mixed block minus mean RT in the pure single-task blocks) or switching costs (mean RT on switch trials minus mean RT on repeat trials). These null results contrast with the bilingual advantage in switching costs reported by Prior and MacWhinney [4], but are completely consistent with the null results reported in six recent experiments using large numbers of bilinguals and monolinguals [3, 2, 5]. The cumulative evidence overwhelmingly favors the conclusion that there are no differences between bilinguals and monolinguals in switching ability. Participants also responded to two category fluency probes (musical instruments and vegetables), two verbal fluency probes ("F" and "A"), and two probes to alternate between two categories (e.g., furniture and fruit) and between two letters (e.g., "S" and "T"). Consistent with previous research monolinguals generated more correct responses in these tasks. Of more interest is the new finding that none of these verbal fluency tasks correlate with any of the measures of switching ability. These findings do not align with the clinical and neuroimaging evidence suggesting that verbal ability may be more strongly reflected in category than in letter fluency scores, and that, conversely, executive functioning may be more strongly reflected in letter fluency scores [6].

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8. Relating the demands of bilingual language control to inhibition: An individual differences approach

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individual differences; inhibition; executive functioning; bilingualism; language similarity; language use

Language is one of the most complex feats of the human mind and brain, involving the retrieval and manipulation of symbols to produce a nearly infinite set of communicative structures. Bilingualism greatly increases these demands, as two sets of symbols, and two sets of rules for manipulating them, must be “managed” in one brain. Much research has been devoted to measuring the broader implications that these demands have for bilingual cognition. For example, a plethora of research has shown that bilinguals exhibit superior inhibitory control to monolinguals, suggesting that the additional demands associated with bilingual language control train general executive processes (see Bialystok, Craik, & Luk, 2012 for a review). Recently, however, these findings have been called into question (e.g., Paap & Greenberg, 2013). We argue that an improved understanding of the facets of bilingualism that likely drive the neurocognitive demands associated with bilingual language control (e.g., language similarity and language use habits) should be central to this research, as it has been widely acknowledged that bilingualism is not a dichotomous variable. In the current experiment, we investigated individual differences in inhibitory control in a total of 423 individuals with bilingual backgrounds. Participants were included if they indicated having experience with two or more languages on a language history questionnaire. Data from the same version of a Simon Task were pooled from three investigations of executive functioning. The Simon Effect (a metric of inhibitory control) was indexed by subtracting incongruent reaction times (RTs) and accuracies from congruent ones, although all significant results were from RT indexes. The primary independent variables of interest were linguistic distance (Chiswick & Miller, 2005), and current language usage, calculated as the percentage of time over the past month that participants used their dominant language (lower numbers indicate more balanced bilinguals). We also correlated second language (L2) age of acquisition and proficiency with inhibitory control. The results showed that linguistic distance was correlated with the Simon Effect, $[r(191) = .32, p < .001]$, suggesting that individuals who speak languages that are distantly related have better inhibitory control. Additionally, language use was positively correlated with the Simon Effect, $[r(423) = .114, p = .019]$, suggesting that individuals who use both languages regularly have better inhibitory control. Finally, both age of L2 acquisition and L2 proficiency significantly correlated with the Simon Effect $[r(268) = .15 \text{ and } -.14 \text{ respectively, } ps = .018 \text{ and } .025 \text{ respectively}]$, with early and more proficient bilinguals exhibiting better inhibitory control. The results of this exploratory analysis demonstrate the importance of not treating bilingualism as a homogeneous category, and highlight the significance of two largely understudied features, language similarity and language use, on indices of inhibitory control.

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9. Congenital amusia and executive functioning

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Executive functioning, Stroop, Congenital amusia, Musical experience

Congenital amusia is a life-long musical disorder that cannot be explained by mental retardation, deafness or lack of exposure [1]. Amusic individuals tend to listen and enjoy musical activities less than the normal population does. As a consequence, amusics may show impairments in general cognitive functioning. Indeed, there is increasing evidence that musical experience enhances cognitive functions in general [2], not just musical abilities.

Here, we explore whether the limited and abnormal musical experience of amusic adults leads to diminished executive functioning. To this end, amusic individuals and matched non-amusics with and without musical training first completed executive and control conditions in the visual domain, in a situation referred to as the Simon arrows task [3]. As expected, musicians were faster than both amusics and nonmusicians. However, this difference in speed of processing was not associated to different sensitivity to conflict.

The amusic adults were also tested with the Stroop task. The cognitive control condition (ex. the word **GREEN** written in red ink) and the control conditions (color naming and reading) were all performed within the normal range. They performed within the normal range in the cognitive control condition.

Thus, these findings rule out a general executive impairment as a source of musical difficulties in congenital amusia.

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10. An Investigation of Switching Cost through Lexical Decision Task

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Switching cost; L1-L2 processing; Visual word recognition; Monolingual and mixed context; Chinese English

The recent decade has witnessed a growing body of research examining the issue of bilingual language switching cost: a “paradoxical” asymmetry in the cost of switching language has been observed consistently-- the language switching cost was larger when switching to the first language (L1) from the second language (L2) than vice versa (Costa et al., 2004; Finkbeiner et al., 2006; Guo et al., 2011; Meuter & Allport, 1999; Misra et al., 2012; Philipp & Koch, 2009). Such findings are both explained by and supporting the Inhibitory Control model (Green, 1998) -- task schemas exert control within the bilingual lexicon by activating and inhibiting corresponding language nodes, and a stronger language requires more energy to inhibit and thus becomes more difficult to access. In spite of the consistent evidence, two questions remained unexplored. First, most existing studies on the topic used a naming task. In contrast, few studies used a receptive task such as lexical decision. Thus, it is not clear whether the asymmetry in switch costs is limited to production or applies to both production and recognition. Second, switching costs were not always separated from mixing costs in previous studies. Therefore, the current study attempts to investigate whether there is an asymmetrical switching cost in a word recognition task and whether reaction times (RTs) differ under monolingual and mixed conditions.

Thirty Chinese-English bilinguals completed three lexical decision tasks -- a Chinese monolingual condition, an English monolingual condition, and a mixed language condition. Critical stimuli in the mixed list consisted of both nonswitching and switching trials in both languages. A large number of fillers were added to minimize strategy and position effect. RT data was analyzed in two 2 X 2 Repeated Measures ANOVAs – language (Chinese vs. English in mixed condition) X switching (Switching vs. Nonswitching) and language (Chinese vs. English) X List (Monolingual list vs. nonswitching trials in Mixed list). While both analyses revealed a main effect of language, we did not observe a main effect of switching or a main effect of list, nor a significant interaction effect . In other words, unlike in production tasks, asymmetrical language switching cost did not occur in a word recognition task. In addition, participants did not respond significantly faster in a monolingual condition than in a mixed language condition. We offered two explanations in line with our findings. First, while production task requires a top-down processing route through which inhibition is likely to be obligatory, word recognition task triggers bottom-up processing in which inhibition and suppression of the other language is not a necessary step. Second, an alternative explanation is that asymmetrical switching cost is more likely to be found in unbalanced bilinguals, but not among those highly proficient L2 learners who have been immersed in an L2 context for a rather long period of time.

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11. The effect of taxing inhibitory control on bilingual language switching: Evidence from dual-task paradigms

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Bilingualism; Language production; Inhibitory Control; Language Switching; Dual task

An influential account of how bilingual speakers manage interference between languages is the *inhibitory control* (IC) *model* [1], which proposes that bilinguals rely on domain-general IC mechanisms to suppress the non-target language. Much of the evidence for the IC model is correlational; for example, individuals with higher scores on IC tasks tend to perform better on language-switching tasks (e.g., [2]) and findings of a “bilingual advantage” on IC tasks suggest that bilinguals’ extensive practice in controlling languages may transfer to improved IC abilities (e.g., [3]).

The current experiments aimed to go beyond these correlational findings by assessing language-switching costs while simultaneously manipulating demand on IC. If language switching requires IC, then taxing participants’ limited IC resources should increase language switching costs. In Experiment 1, participants switched between naming pictures in English (L1) and Spanish (L2) while simultaneously performing a Simon arrows task (responding to the direction of an arrow that could appear on either side of the screen while ignoring its location). Surprisingly, language switching costs were *reduced* during incongruent (vs. congruent) Simon arrow trials; i.e., switching was actually *easier* when IC was taxed. (Note that a control experiment pairing language switching with a task manipulating perceptual difficulty produced no such interaction, suggesting that these findings did not simply reflect the difficulty of a secondary task).

This reduction in language switching costs during an IC demanding dual task might reflect task prioritization, such that participants tended to prioritize the language task when IC demands were high. Experiment 2 thus used a paradigm requiring only one response, by combining language switching with a picture word interference paradigm, wherein conflict was manipulated via the relationship between to-be-named pictures and simultaneously presented distractor words. This task requires only one response (thus eliminating the possibility for differential task prioritization) and also involves conflict between lexical representations, which may be more analogous to conflict involved in language switching. However, switching costs were again not exacerbated when IC was taxed; if anything, switching was *less* costly during inhibition-demanding trials (with related distractors).

Experiment 3 tested whether these reduced switching costs in IC demanding contexts reflect *conflict adaptation*, where high conflict trials can lead to reduced conflict on following conflict trials (cf. [4]). Experiment 3 thus interleaved Simon arrow task trials with language switching task trials. Although conflict adaptation was observed across trials of the Simon arrow task, there was no evidence that this Simon conflict influenced language switching.

Overall, these findings fail to support a straightforward role of IC in bilingual language switching and suggest that language control, at least in the context of language-switching tasks, may not draw on domain-general IC.

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12. Individual differences in cognitive and language control in advanced age among late Dutch-English bilinguals

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Healthy aging; Language proficiency; L1 attrition; Working Memory (WM); Set shifting tests; Language use ; Dutch; English

Recent years have seen a host of studies on healthy aging. The topicality of healthy aging fits in well with the increasingly larger proportion of elderly in developed countries [1]. It is well documented that cognitive resources tend to decline with age: processing speed, working memory, attention span and inhibition mechanisms are all reported to suffer due to changes in the neural substrate [2]. It is equally well known that such cognitive decline impacts on language. Intriguing in this respect is the now well-known research trend on cognitive and language controls in bilinguals. This work suggests that early bilinguals may possess a safeguard against age-related cognitive decline, even to the extent that the onset of dementia can be delayed substantially [3], [4]. However, mixed findings characterize this line of research, and even more so when late bilinguals are investigated. Not only is language and cognitive control in elderly late bilinguals vastly under-researched, but even studies on college-aged late bilinguals are far from uniform in their outcomes: while some work has found cognitive advantages for late bilinguals in their 20s, others have not [5], [6], [7].

In this study, an attempt is made to shed more light on this issue by examining a group of older (71+) late Dutch-English bilinguals, all L1 Dutch long-term émigrés in Australia. They took part in a series of language tests (comprising among other things language use and history questionnaire, vocabulary, and grammar measures) and cognitive measures (consisting of several working memory tasks, inhibition tasks, processing speed measurements, and set shifting tests). Their data were compared against youngest old (60-70) and middle-aged (40-50) controls. In addition, data was collected from age-matched Dutch and English monolingual control groups. The results show that, rather than the bilinguals outperforming the monolinguals as a group, individual differences very much characterize the findings. A three-way distinction emerged where a subset of the older bilinguals performed on a par with the monolinguals, while two other subsets produced markedly lower and markedly higher scores than the monolinguals, respectively. In other words, while a subset of the data appear to point in the direction of a bilingual cognitive advantage, another part of the data support an 'overloading' hypothesis where bilingualism hampers rather than facilitates performance on cognitive and language measures. Yet another subset suggest an indifferent result of late bilingualism. Although the oldest group often did produce poorer scores than their younger peers, this was not uniformly the case and the best performing oldest subjects often outperformed their younger peers on language and cognitive tasks alike.

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13. It's not that simple: Sequential congruency effects reveal a bilingual disengagement advantage

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Conflict adaptation; Sequential congruency effects; Bilingual advantage; Disengagement; Language

Behavioral evidence for cognitive control changes as a function of bilingualism on conflict resolution tasks and other higher-order executive function tasks has accrued for infants, children, adolescents, and older adults. Surprisingly however, this performance benefit is less consistently found in the young adult population. This has led some researchers to believe that there is no cognitive control advantage at all for bilinguals. Given that a bilingual advantage has been reported across the lifespan in multiple areas of cognitive control, we explored the possibility that previous analyses may have been too simplistic for the young adult population who are at peak cognitive performance. We examined the possibility that null performance effects on one of the most commonly used conflict resolution tasks in young adults come about by not taking into account the influence of conflict on previous trials. Bilinguals and monolinguals completed a flanker interference task. When we examined the typical flanker interference effect (difference between incongruent and congruent RTs), no effects involving group emerged. However, when we included previous trial congruency as a factor in the analysis, it was clear that bilinguals were less influenced by previous trial congruency than were monolinguals. We suggest that bilinguals are better able to rapidly disengage attention from previous trial congruency.

14. The Effect of Second Language Proficiency on Inhibitory Control: An Ex-Gaussian Analysis

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Inhibition; Second language acquisition; Reaction time; Ex-Gaussian

Several studies have reported superior performance on executive function tasks for bilinguals compared to monolinguals (e.g., Bialystok et al., 2008). However, some researchers have reported issues replicating this effect (e.g., Paap & Greenberg, 2013). Two common methodological choices may account for the inconsistent findings. Most published research has treated bilingualism as a categorical variable and focused on RT means rather than other distributional parameters.

Most studies of executive functioning in bilinguals include those with high proficiency in both languages. However, bilinguals also include those with non-balanced proficiencies of various levels, meaning that degree of bilingualism is in fact a continuous variable. The strength of cross-language interference is likely modulated by the degree of bilingualism, suggesting that executive functions may improve as L2 proficiency develops. In this study, we tested the relationship between L2 proficiency and performance on an inhibitory control task.

Most published research on this topic has used RT means as the dependent measure. However, theoretical models of RT imply that distributional tails are often more sensitive to individual differences (Balota & Yap, 2011). One promising approach to studying individual differences in cognitive processing is examining ex-Gaussian parameters from RT distribution, which include separate parameters for central tendency and tails. Calabria et al. (2011) re-analyzed two existing data sets and found that bilinguals had smaller central tendencies (*mu*) and tails (*tau*) across both congruent and incongruent trials, but a bilingual advantage in the difference between congruent and incongruent trials was only observed in *tau*.

In this study, we tested 42 native speakers of Brazilian-Portuguese with varying degrees of English (L2) proficiency using a Flanker task. We predicted that L2 proficiency would correlate negatively with both *mu* and *tau* in overall RTs. Furthermore, we expected a three-way interaction between proficiency, parameter (*mu*, *tau*), and condition (congruent, incongruent) showing an effect of proficiency on *tau*, but not *mu*, for incongruent, but not congruent, trials.

Ex-Gaussian parameters were estimated and analyzed in a mixed-effects model with proficiency, parameter, condition, and their interactions as fixed effects. Results revealed a main effect of proficiency ($B = -59.56$, $t(76.9) = -2.21$, $p = .03$), and an interaction between proficiency and condition ($B = -53.184$, $t(120) = -2.54$, $p = .01$), indicating that higher-proficiency participants had smaller parameter estimates across both conditions and that this effect was larger in the incongruent condition. The interaction between proficiency and parameter was non-significant as was the three-way interaction between proficiency, parameter, and condition.

The results suggest that bilinguals have better performance across conditions with increasing proficiency, but the pattern is larger for the incongruent than congruent condition. These findings may indicate that bilinguals with higher L2 proficiency develop not only inhibitory control but also overall efficient processing abilities.

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15. Bilingualism facilitates the monitoring of different cognitive control mechanisms

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Bilingualism; Flanker task; Interference suppression; Monitoring; Response inhibition

Recent research shows that bilinguals excel monolinguals in coordinating different executive functions [1] [2]. We further explored this idea by employing an adapted version of the flanker task, which allowed for the measurement of interference suppression (congruent vs. incongruent trials) and response inhibition (go/no-go blocks). Importantly, we could also observe the performance with varying task demands. In the conflict condition, participants must ignore the flanking distractors and focus only on the direction of the target chevron to suppress interference. In the go/no-go blocks participants needed to pay attention to the flanking information to respond. Crucially, apart from these single blocks, there were mixed blocks (composed by intermixed trials of go/no-go and conflict blocks) that required an increase of monitoring resources since participants needed to process the flanking information and use it or ignore it depending on the demands of the trial.

In line with previous research, our results indicated that bilingualism benefited the performance in the mixed condition, where different cognitive control resources needed to work together to achieve the highest efficiency. We relate these results to the performance in the AX-Continuous Performance Task (AX-CPT), which also requires participants to combine different control mechanisms (e.g., to withhold a prepotent response while maintaining context information). These data provide further support for the idea that bilingualism modulates the functioning of a whole cascade of processes engaged in cognitive control.

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16. Simultaneous interpretation as a cooperative language context

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Simultaneous interpretation; Inhibitory control; Language switching; Multilingualism; n-2 repetition cost

Simultaneous interpretation is an impressive cognitive feat which requires an individual to comprehend a stream of auditory material in one language and with a few seconds delay produce the same content in another language. This task necessitates the simultaneous use of two languages and therefore begs the question: how is language management accomplished during interpretation? One possibility is that interpretation represents a cooperative language context, similar to dense-code switching. In such a context both languages are maintained active and inhibitory control is reduced.

To examine whether inhibitory control is reduced after experience with interpretation, four groups of students with varying experience were assessed on a three language switching paradigm. The four student groups represented a full crossing of two experience variables: training in interpretation and recent practice with interpretation. The three language switching paradigm provided an empirical measure of the inhibition applied to abandoned languages. Trials which required a return to the language used two trials previously (e.g., English – Italian – English) were compared to trials which did not require a language repetition (e.g., French – Italian – English). The difference between these trials types, termed the n-2 repetition cost, provides an empirical signature of inhibitory control processes [1,2].

The four groups of students showed different patterns of n-2 repetition costs across the three languages (L1, L2, L3). These different patterns, however, did not appear to be connected to either training in interpretation or recent practice with interpretation. Instead, the differences may be due to other language characteristics. In particular, the n-2 repetition cost in the L2 correlated with self-rated speaking and understanding in the L2 ($r = -.237, p = .053$ and $r = -.316, p = .009$, respectively), suggesting that language proficiency may affect the use of inhibitory control in language management. The differences seen in the L1 n-2 repetition cost, on the other hand, may be due to the differing predominant bilingual interactional contexts of the groups. These results speak to the role that proficiency and interactional context have on language management and in turn on cognitive control abilities domain-generally. Further, these data promote the use of n-2 repetition costs as a pure measure of inhibition in switching tasks.

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17. The Effect of Translating and Interpreting Experience on Young Adults' Cognitive Control Development ---A Longitudinal Study

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bilingual advantage, cognitive control, translation, interpreting, switching

Previous studies indicate that the bilingual experience of interpreting brings about the switching advantage of cognitive control, but this bilingual experience of interpreting generally includes trainings of both written translation and oral interpretation. To tear apart the two in the research of cognitive control may help answer the question of what exactly brings about bilingual advantages.

The present longitudinal study investigated how the two specific bilingual experiences of translating and interpreting would influence cognitive control development in young adults. After matching participants' relevant features in the pre-test, we compared the post-test performance on the number Stroop task, color-shape switch task, WCST, 2-back updating task and two working memory span tasks across three groups of Chinese-English young adult bilinguals, who differed mainly in their half-year long bilingual experience: one for English (L2) learning, one for translating and one for interpreting. The results show that the interpreting experience enhanced switching ability significantly in both color-shape and WCST tasks. The translating experience tended to improve performance in a 2-back updating task and one switching task (color-shape), but the effect was insignificant and not as large as that imposed by the interpreting experience. The findings indicate that more practice of verbal switches may predict better non-verbal switching abilities, and that the underlying cause of bilingual advantages probably lies in the processing immediacy of an additional language which is definitely more demanding than that of a single language.

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18. Cognitive control in interpreting

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Bilingualism; Cognitive control; Interpreting; Simon task; Stroop; Conflict resolution; Working memory; fMRI

Multilinguals, who use their languages on a daily basis, show cognitive advantages; especially, when control requirements are high [1]. How is this finding related to one specific subgroup of highly proficient bilingual speakers: interpreters, who professionally use their cognitive control skills on a daily basis?

In the present pilot-study, we compared a group of 13 highly proficient bilingual speakers with a group of 13 professional interpreters. All participants were recruited in Brussels and we controlled for second language proficiency, gender, and age. All participants completed the color Simon task and the numerical Stroop task, and both the accuracy rates and the reaction times were collected.

The results of our study show that both the highly proficient bilingualism group and the interpreter group perform extremely well on both cognitive control tasks. For the Simon task the following accuracy scores for the highly proficient bilinguals are found: 95.59% ($SD = 13.52\%$) on the congruent items and 94.49% ($SD = 13.65\%$) on the incongruent items versus for the interpreters 98.56% ($SD = 2.91\%$) on the congruent items and 98.10% ($SD = 2.70\%$) on the incongruent items. Both groups show similar accuracy scores ($p > .05$). The analysis of the reaction times shows that both groups do not differ significantly ($p > .05$). The results of the numerical Stroop task show a similar pattern. The highly proficient bilinguals are 94.08% ($SD = 15.85\%$) correct on the congruent items and 89.22% ($SD = 15.54\%$) on the incongruent items versus for the interpreting group 98.39% ($SD = 2.40\%$) on the congruent items and 93.56% ($SD = 4.26\%$) on the incongruent items. No significant differences in accuracy scores and reaction times are found between the two groups ($p > .05$).

To conclude no differences in accuracy and processing time were found on both cognitive control tasks between groups, indicating that the interpreters' advantage over non-interpreter bilinguals do not extend to conflict resolution. These results are consistent with other studies that fail to report any professional interpreters' advantages in tasks that require interference control such as the Stroop [2] or the Simon tasks [3]. This pilot study is part of a bigger project on cognitive control in interpreting. The focus will be on other control components which are involved in interpreting, such as working memory (verbal/ non-verbal) and the attention network, using both behavioral tests and functional magnetic resonance imaging in a longitudinal research design.

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19. Are all code-switchers equally “switched-on”? Exploring the differential impact of code-switching styles on bilinguals’ executive control functions.

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bilingualism and cognition; executive control functions; code-switching; bilingualism and mental flexibility

This poster explores the question how code-switching (CS) modulates executive functions. Bilinguals’ inhibitory advantages are attributed to frequent practice at suppressing co-activated non-target varieties in monolingual contexts. CS however allows co-activated varieties to reach articulatory stages raising the question to which extent inhibition is recruited. The flipside of not inhibiting languages is practice at task-switching as the co-activated varieties need to be managed (Green & Wei, 2014). Three types of CS varying in degree of L1-L2 co-activation and resulting inhibitory control and task-switching involvement have been described (Muysken, 2000): alternation (L1-L2 phrase juxtaposition involving little co-activation), insertion (L2 constituents embedded in L1 structure with co-activation of lexical schemata), dense CS (co-activation of grammatical, lexical and semantic schemata). The emergence of these patterns depends on speakers’ language history and dominance profiles. The linguistic characteristics of the three types of CS lead to the prediction that late bilingual L2-users are more likely to use their dominant L1 as the matrix language fostering insertional code-switching. Heritage speakers in established bilingual communities may mix languages more densely.

This study measured executive functions amongst two groups of German-English bilinguals with different CS profiles: German L2-users of English engaging predominantly in insertional CS and German heritage speakers in South Africa with a greater preference for dense CS. The independent factor CS preference is treated as a continuous variable to capture individual variation using multiple methods: questionnaires creating scores for CS frequency, intentionality, type and attitude, elicited and authentic emails tapping into free production, acceptability judgement and sentence repetition tasks indicating cognitive embedding. The dependent variable executive control performance is tested using flanker tasks. Tasks are arranged into blocks varying in degree of task-switching thus generating not only a conflict effect measuring inhibition, but also a mixing cost measuring mental flexibility (Costa et al., 2009). As dense CS recruits and enhances inhibition least and task-switching most, increased preference for dense CS is predicted to correlate positively with conflict effect and negatively with mixing cost. Moreover, bilinguals are predicted to outperform monolinguals in conditions requiring greater mental flexibility. Indeed preliminary pilot study results reveal the most salient bilingual conflict effect advantages in blocks challenging mental flexibility most. Scores from the acceptability judgement display a negative relationship with mixing cost for all CS types, but this correlation only reaches significance for dense CS ($r = -0.56$; $p < 0.05$). This indicates that mental flexibility is enhanced most by the type of CS involving linguistic co-activation at multiple levels.

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20. Linguistic code-switching affects executive function in some bilinguals: First results from a new methodology

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Code-switching; Bilinguals; Executive FunctionIn this study, we examine the link between code-switching (CS; alternating between two or more languages within a conversation) – and executive function (EF). Past work revealed that language switching is challenging and requires cognitive control, and similar brain regions are activated during language switching and EF tasks (Abutalebi & Green, 2007). Others have speculated that CS may enhance cognitive advantages attributed to bilingualism. Although there has been some work suggesting that more frequent language switching correlates with better EF task performance (Soveri, Rodriguez-Fornells, & Laine, 2011; Yim & Bialystok, 2012), to date there has been no evidence that within subjects, CS and EF interact directly.

This raises the prediction that mechanisms of EF and CS in bilingualism would interact, leading to behavioral effects. In fact, a reciprocal interaction might be possible. This prediction is tested here with a new paradigm to assess direct interaction between EF and CS, to see if depletion of EF will lead to a diminishment of CS productivity. Furthermore, given that the nature of bilingualism varies so widely, we test whether this hypothesized effect would correlate with participants' self-reported frequency of mixing, attitudes towards CS, and level of bilingualism.

To measure CS, participants discussed topics and switched languages upon hearing a beep. CS performance was quantified by several measures including the reaction time (RT) taken to switch into another language after the beep. Participants completed two CS tasks – one at the start (CS_1) and one after EF depletion (CS_2). We used the Stroop (in both languages; all incongruent trials) and a verbal task switching (Yim & Bialystok, 2012; see Appendix) to deplete participants' verbal EF.

Initial data analyses included 17 Chinese-English bilinguals (8 females, $M = 21.4$ ($SD = 1.3$)) varying in nature of bilingualism (Table 1). Correlational analyses revealed that RT difference (i.e., whether participants took longer time to switch in CS_2) was negatively correlated with: a) attitudes towards CS, b) frequency of mixing, and c) verbal task switching scores (Table 2). Level of bilingualism was not significantly correlated with RT difference. Linear regression revealed that only **frequency of mixing** marginally predicted RT difference ($R^2 = .21$, $SE = .46$, $p = .068$). This suggests that those with positive attitudes towards mixing languages who frequently mixed languages were less likely to be negatively affected by the verbal EF depletion, as seen by their CS_2 performance. Our results have implications for a general theory involving the representation of general cognitive processes such as EF and linguistic mechanisms of control.

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21. Processing code-switching in Algerian bilinguals: Effects of language use and semantic expectancy

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Code switching (CS), that is the alternation between languages in bilinguals, is mainly conversational and contextual and is often observed in informal situations. This suggests that it is easier and more economical to mix languages than to keep them separate in certain contexts (Rodriguez-Fornells et al., 2012). It is therefore essential to explore switch costs in different bilingual contexts (Heredia et al., 2001; Green, 2011). This study investigates the switch costs in Algerian Arabic-French bilinguals who frequently code-switch, using contexts in which CS is more or less typical. A total of 134 bilinguals are tested using a bi-modal (auditory and visual) design to investigate code switching during listening. Experiment 1 explores whether a semantic context that is highly predictive of a cognate at the switch point (1) facilitates switching and eliminates switch costs.

- (1) a) J'ai besoin d'argent, je dois passer aujourd'hui à **la banque**. (Cognate)

"I need money, I have to go today to the bank."

- b) نَبْحَاقُ إِلَيْكُمْ لَذَّةُ الْيَوْمِ إِلَيْهَا **la banque**.

"I need money, I have to go today to the bank."

Experiment 2 investigates whether the habit of switching between a pair of languages rather than another pair of the languages that the bilingual speaks affects the expectation of switching. Since Algerian bilinguals code-switch between Algerian Arabic and French, but not between Standard Arabic and French, a context with Algerian Arabic as the base language may trigger CS compared to when the base language is Standard Arabic, making of Algerian Arabic-French CS (2-a) rather more expected and less demanding than Standard Arabic-French CS (2-b).

- (2) a) Ki kunt nqaʃar fi lbatʃat'a qatʃat'sabʃi b- **le couteau**. (Non-cognate)

"When I peeled the potatoes I cut my fingers with the knife."

- b) ؟indama kuntu ?uqaʃiru el batʃat'a qatʃat'sabʃi b- **le couteau**.

"When I peeled the potatoes I cut my fingers with the knife."

Given that participants are frequent code-switchers, we expect a cognate effect to survive in the switching condition. A cognate switch is named faster than a non-cognate switch, suggesting that both languages are activated while listening and that this activation facilitates switching. In other words, CS is easier when the switch is a familiar word that shares semantic and lexical information in both languages. However, we predict that the listeners do not anticipate a language switch when the base language is Standard Arabic. This supports the idea that the bilingual's readiness to code-switch is constrained within language use (Meuter, 2009). The fact that a bilingual speaks two languages does not guarantee the occurrence of CS. This also suggests that the control processing during CS depends on the speaker's habitual language use (Green & Wei, 2014).

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22. Contributions of bilingualism and public speaking training to cognitive control differences among young adults

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Bilingual advantage; bilingual experience; public speaking training; conflict monitoring, mental set shifting

The Flanker task, the Number Stroop task, and the Wisconsin Card Sorting Test (WCST) were adopted to examine how bilingualism and public speaking training contribute to cognitive control differences among young adults. Four groups of participants were tested: monolinguals, general bilinguals, Chinese (L1) public speaking bilinguals, and English (L2) public speaking bilinguals. ANOVA and regression analyses showed that: 1) the speaking groups performed faster than the other two groups in the Flanker task (i.e., better in conflict monitoring), whereas the L2 public speaking group performed the fastest in the Number Stroop; 2) The three bilingual groups performed better than the monolinguals in the WCST (i.e., better in mental set shifting), and this advantage was more robust when L2 proficiency was higher. The results show that specific aspects of language experience may incur enhancement in specific aspects of cognitive control. These findings actually lend support to the recently proposed view by Valian (2015) that benefits from bilingualism are inconsistent because individuals vary in the number and kinds of experiences they have that promote superior cognitive control.

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23. Referential choice in a second language: evidence from highly proficient learners of English

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Referential choice; syntax; English; Spanish

The ability to refer to entities in the surrounding world constitutes a prerequisite for successful communication. Native speakers use attenuated forms (e.g., pronouns or phonologically silent elements) when the referent is in the addressee's focus of attention (e.g., Arnold & Griffin, 2007, A&G). However, they use more explicit forms (e.g., full NPs) when their own focus of attention is distributed among potentially competing referents in the discourse, either through the visual presence (Fukumura et al., 2010) and/or through the previous mention of another animate referent (A&G). Studies on learners of pro-drop languages (e.g., Spanish) have demonstrated that highly proficient second language (L2) learners may over-use pronominal forms when a null subject is required, showing residual indeterminacy in the L2 referential choice (e.g., Sorace & Filiaci, 2006). However, we do not know if learners of a non-null subject language experience similar problems in the choice of referring expression. The present research aims at contributing to fill in this gap, by examining the process of choosing between pronouns and proper names in L2 speakers of English whose L1 is Spanish.

Eighteen English monolinguals and seventeen L2 speakers participated in a story telling task based on A&G. Participants were presented with two pictures that contained: (1) one character in the first panel and one in the second panel; (2) two characters in the first panel and two in the second panel (different gender); (3) two characters in the first panel and one in the second panel (different gender); (4) two characters in the first panel and one in the second panel (same gender). After listening to a description of the first panel, participants were asked to describe the second panel.

For native speakers, even when a pronoun would not be ambiguous, the presence of another character in the discourse (either in the first panel or in both panels) decreased pronoun use to refer to the most prominent character in the discourse. For the L2 group, results showed a higher production of pronouns than in native speakers when there were two characters in the preceding discourse who had either similar or different gender. We conclude that the production of referring expression is susceptible to L1 interference in highly proficient learners of English. We hypothesize that L2 participants fail to suppress the assumption from their native language that overt pronouns are interpreted as referring to a non-topic referent. The learners produced more overt pronouns in two-referent contexts than native speakers of English likely because an overt pronoun is more explicit for them than a null form. While it may seem that they are being more explicit, in fact they are not yet explicit enough as an English native speaker.

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24. The effects of bilingualism on interference control tasks: a meta-analysis.

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Bilingualism; executive control; inhibitory control; meta-analysis; multi-level models.

An open question in cognitive science is whether and under what circumstances bilinguals outperform monolinguals on interference control tasks. Results have been mixed on both interference costs (Hilchey & Klein, 2011) and global RTs (Paap & Greenberg, 2013). One explanation for this variability is variation across studies in tasks, age and labs. This poster reports on a meta-analysis synthesizing these studies and testing the effects of four potential moderators (described below). The analysis contains 73 comparisons from published studies, reflecting 5538 unique participants.

Moderators tested include RT cost, task, participant age, and lab. RT cost refers to whether the effect size reflects global RT or interference cost. These costs are thought to reflect separable components of executive function and are implicated in different models of bilingual language processing (Hilchey & Klein, 2011). Task refers to the type of interference control task included, Simon, Flanker, Stroop or other. While these tasks are all considered interference control tasks, they are often uncorrelated (Paap & Sawi, 2014). Age was coded categorically and includes three groups: children, younger adults and older adults. Finally labs that contributed more than four effect sizes were included as separate dummy coded variables.

The effects of these moderators were tested in a series of three-level meta-analyses. Three-level meta-analysis explicitly models the dependence between effect sizes from the same sample and was necessary since most samples contributed effect sizes for global RT and interference cost. A first model, which included no moderators, yielded an effect size of $d = .39$ ($CI: .19 - .59$). A second model, which included RT cost as a moderator, did not significantly improve fit ($p = .52$). However, as it is plausible that the effects of other moderators might be different for global RTs and interference costs, RT cost was included in all subsequent models, despite being non-significant on its own. Subsequent models revealed no main effect of task, and no interaction between task and RT cost. There was no main effect of age, but a significant interaction between age and RT cost; for older adults differences in interference costs were larger than global RTs while for children differences in global RTs were larger than differences in interference costs. There was a significant main effect of lab, but it did not interact with cost.

The significant interaction between age and RT cost is difficult to interpret. The significant main effect for lab may be driven by differences in subject pools, differences in defining and handling outliers in RT distributions or other methodological factors.

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25. Bilingual advantage in inhibitory control: Variations across inhibition tasks

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bilingual; inhibitory control; inhibition tasks; age; review

Green proposed that bilinguals exert inhibitory control during everyday conversations, as they need to suppress the production of the language irrelevant to the conversational context [1]. This inhibitory control is monitored by the supervisory attentional system, which is the same system believed to be involved in general executive functions. Given their lifelong practice in suppressing their irrelevant language during speech, Bialystok suggested that bilinguals should show better performance than monolinguals in general inhibitory control [2]. In the present analysis, I reviewed existing findings to investigate whether bilinguals showed this advantage in all inhibitory functions, or in specific functions that are more closely related to the inhibitory control in bilingual language use. Following Friedman and Miyake's framework of inhibitory functions [3], I hypothesized that the bilingual advantage would appear predominantly in tasks that involve prepotent response inhibition and resistance to distractor interference, but not in those related to resistance to proactive interference. I further explored whether unbalanced bilinguals would show an additional advantage in prepotent response inhibition over balanced bilinguals, given their need to override their dominant first language when speaking their second language. Results of this analysis indicated that the bilingual advantage in inhibitory control was not consistently found in the literature. Nevertheless, there was some support for the hypothesis that this advantage was more commonly found in tasks related to prepotent response inhibition and resistance to distractor interference than in tasks related to resistance to proactive interference. More interestingly, the results also suggested that the bilingual advantage in the former two inhibitory functions differed across age groups, leading to the speculation that bilinguals' development in these functions might follow distinct trajectories. Lastly, there was no evidence that unbalanced bilinguals had an additional advantage in prepotent response inhibition over balanced bilinguals. The findings of this analysis would provide directions for future research in bilingualism and inhibitory control.

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26. Investigating bilingual memory organization through proactive interference

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bilingualism; bilingual memory organization; cross-language interference

The extent to which bilingual memory is language (in)dependent remains a matter of scientific debate. In this study, we used the n-back recognition paradigm in order to obtain a better understanding of dual-language control in bilinguals' memory. Therefore, we tested Dutch-French balanced bilinguals on several variants of a 2-back task involving so-called lure trials. In this task, participants are required to indicate whether a word matches the word that was presented 2 positions before (e.g., huis-vork-lamp-vork is an example of a 2-back match). In this 2-back procedure, lure trials are mismatch trials where the novel word matches the word that was presented just before the word in target 2-back position (e.g., the 2-back trial vork-fiets-lamp-vork). It has been demonstrated that 2-back recognition performance is interfered by such lure trials [1]. This lure interference effect is assumed to reflect a competition between familiarity matching and recollection in recognition memory. In the present study, we created a bilingual version of the 2-back paradigm, where half of the words were in the first language (L1) or the second language (L2). In a series of experiments, we observed comparable lure interference effects in both languages and more interestingly, we also found a cross-language lure interference effect (e.g., fourchette-ezel-huis-vork) as well as interference from cross-language semantically related lures (e.g., couteau-ezel-huis-vork). We further also showed that cross-language interference only emerged when 2-back recognition was driven by recollection memory rather than by familiarity-matching. The implications of these findings for bilingual memory and for dual-language control more generally are discussed.

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27. The effects of bilingualism on executive control functions in auditory selective attention

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Bilingualism; Young adults; Auditory Simon task, Auditory Flanker task; Quick SIN; Auditory selective attention

Bilinguals show gains in performance on executive control tasks compared with monolinguals, the so-called *bilingual advantage* [1]. Most studies have examined the effects of bilingualism on children [2-5] and older adults [6-9] in visual executive control tasks with relatively little research done in college-aged populations [10-12]. The current study evaluated the bilingual advantage in auditory perception in college-aged students. Previous research had shown that bilinguals are worse than monolinguals at identifying speech in noisy environments [13-14]. Thus, one might predict a monolingual advantage in auditory perception, especially for language stimuli such as speech. This study, however, aimed to look at the effect of executive control functions in auditory selective attention tasks by taking a nonverbal approach, using tones to control for language intelligibility effects. Spanish-English bilinguals and English monolinguals were tested in an auditory Simon task, an auditory flanker, and a task to detect speech signals in noise (QuickSIN). In the auditory Simon, participants identified the pitch of tones in lateral positions, ignoring the spatial location of the target sound. In the auditory flanker, participants judged the pitch of the second of three sequential tones, ignoring the pitch of the two flanking tones. Results indicate a bilingual advantage in suppressing irrelevant spatial and auditory information, as in the auditory Simon. However, there was a monolingual advantage in identifying pitch in the midst of distractors, as in the auditory Flanker and QuickSIN. This suggests that the beneficial effects of bilingualism on executive control functions extends across sensory modalities but is limited to certain conditions.

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28. What colour is 赤? Investigating cognitive control in multi-script bilinguals

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Bilingual cognitive control; multi-script bilingualism; logograph processing; Japanese; Stroop task

A growing body of literature suggests that bilingualism affects both our linguistic abilities and our general cognitive abilities. To manage two languages, bilinguals must use cognitive control skills such as attention, inhibition, and task-switching to block one language while using the other. Consequently, there may be general improvement of these skills due to their extensive use in language control. Indeed, previous studies report cognitive control advantages for bilinguals in both linguistic and non-linguistic tasks. The current study investigates whether these advantages are modulated by bilinguals' knowledge and use of multiple writing systems.

There is evidence for a bilingual advantage for older bilinguals¹, more proficient and balanced bilinguals², and bilinguals who had acquired both languages early in life³, but it is only recently that the bilingual context has been implicated⁴; it has been suggested that control processes themselves adapt to language environment demands⁵. The language environment for bilinguals is formed by not only the words heard and spoken, but also by the words read and written. While much research has been done on languages that both use the same script (e.g. alphabet for both English and French), fewer studies have examined cases where one language uses an alphabetic (sound-based) script and the other uses a logographic (semantic-based) script. In the current study, we examine English-Japanese bilinguals and ask 1) Does experience with multiple scripts in the environment modulate cognitive control abilities? and 2) Is the age of acquisition of a logographic script a further factor?

We will present pilot data from English-Japanese bilingual participants who completed two experiments: the first examines linguistic processing using a bilingual Stroop task in which English and Japanese colour terms appear in congruent and incongruent conditions. Crucially, we use only kanji logographs to indicate colour terms in our study. The second experiment examines non-linguistic processing using the ANT task in which sets of arrows appear with the central target in either a congruent or incongruent condition. Accuracy and reaction times are recorded and analysed

Japanese logographs have shown considerable semantic interference effects⁶, and increased naming latencies in cognitive control tasks such as the Stroop test⁷ compared to alphabetic languages. Following the Dual Route Cascaded model of visual word processing⁸, we hypothesize different cognitive advantages for alphabetic-logographic bilinguals based on differences in lexical access of each script. We will discuss our preliminary results in light of this model and the idea that the bilingual cognitive control advantage comes about as a result of experience in managing and allocating limited cognitive resources.

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29. Bilingualism enhances intra-language competition resolution – Evidence from a response distribution analysis

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Bilingual cognitive advantage; Semantic blocking; Lexical selection; Response distribution

It is generally agreed that target and non-target languages in bilingual speakers are concurrently active. This parallel activation poses the need to constantly monitor language production processes. It has been argued that this monitor mechanism recruits a domain general executive control network (e.g. Bialystok & Craik, 2010). As a result, bilingual speakers have been shown to outperform their monolingual counterparts in non-verbal tasks, especially in tasks that require to inhibit task irrelevant information (Bialystok, Craik, Green, & Gollan, 2009). However, little is known as to whether this advantage extends to the control within a language.

In the current study, we investigated whether being bilingual enhances speakers' intra-language control when facing lexical competition. We utilized the cyclic semantic blocking paradigm (Kroll & Stewart, 1994). In this task participants repeatedly name pictures that are blocked into either same category objects (homogeneous condition, e.g. fish, mouse, snake, duck) or different category objects (heterogeneous condition, e.g. tie, snake, brush, lamp). This paradigm leads to slower responses in homogenous blocks than heterogeneous blocks. This is believed to be due to strong lexical competition in homogenous blocks.

We used ex-Gaussian analysis (Ratcliff, 1979) to inspect the distributions of the response times in different conditions. This analysis provides the mean of the leading edge of a distribution (μ), which represents the majority responses, and the mean/standard deviation of the tail of the distribution (τ), which represents extremely slow responses.

We tested monolingual English speakers, highly proficient English/Chinese bilingual speakers and proficient L2 speakers with English as L1. Results from a conventional analysis of variance of average responses in the two semantic homogeneity conditions suggest that all participants suffered from semantic competition to the same degree. However, the results of the ex-Gaussian analysis showed that the participant groups differed in their response distribution profiles. While monolingual speakers showed an effect of the semantic context only in the Gaussian part (μ) of their response distributions, bilingual and proficient L2 speakers showed an effect only in the exponential part (τ) of their response distributions. We argue that an enhanced top-down control mechanism that inhibits lexical competitors best explains the results.

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30. Executive Function Predictors of Learners' Language Processing: A Training Study

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Sentence Processing; L2 processing; Revision; Garden Path sentences; Executive Functions; Cognitive Training; Visual world paradigm

Real time language comprehension and production require focusing on and rapidly integrating multiple sources of information. Growing evidence shows that this process is supported by domain-general executive function (EF) skills. Here we explore whether the ability to process complex sentences in a second language (a) is supported by EF skills and (b) can benefit from EF training.

Over 2 months, 20 Chinese child learners of English played games (www.lumosity.com) aimed at measuring and training EF-skills. Two pre- and post-training sentence processing tasks were also administered. After correcting for age and English proficiency, at pre-test EF skills did not predict performance on canonical (e.g., actives), non-canonical (e.g., passives) and unambiguous structures (e.g., non-reduced relative clauses), but reliably predicted differences in sentence processing for temporarily ambiguous structures requiring revision of initial interpretations (e.g., reduced relative clauses: $\beta = .68$, $t = 4.09$, $p < .01$). After 2 months, the group who underwent EF-training showed improved sentence processing performance compared to an active control group; this improvement was selective to temporarily ambiguous sentences, compared with unambiguous ones, but was present for both canonical and non-canonical structures. In addition, training-related EF-improvements selectively predicted sentence processing improvements for non-canonical ($\beta = .63$, $t = 2.91$, $p = .01$) and temporarily ambiguous structures ($\beta = .77$, $t = 2.93$, $p = .01$), but not for canonical and unambiguous structures.

These results suggest that (a) domain-general EF skills support language processing and (b) training-related gains in domain-general EF skills can transfer to untrained domains (e.g., sentence processing). Such findings represent an important step in identifying the cognitive processes that underlie language processing and development, and the circumstances under which language learners might benefit from domain-general cognitive training.

31. Ambiguity resolution during online sentence comprehension in monolingual and bilingual children

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Garden-path sentences, Syntactic ambiguity, Referential ambiguity, On-line sentence comprehension; Executive Function; Visual world paradigm

Monolingual and bilingual children differ in their language learning environments. Bilinguals split their exposure between two languages, resulting in less experience with each, and have a greater need to monitor language use, possibly leading to a bilingual executive functioning (EF) advantage. In the current study we investigate how these differences affect the development of online sentence comprehension.

Children through age 10 often fail to use top-down information to guide sentence parsing, and subsequently fail to revise their interpretations following inconsistent information. One hypothesis is that these abilities develop with improvements in domain-general EF [1]. Alternatively, these changes may reflect cumulative language experience. Although 5-year-olds have acquired the relevant linguistic structures, they continue to gain processing fluency [2].

In the current study, monolingual and bilingual children (ages 5-7) were given an EF battery, measures of language proficiency (vocabulary and receptive grammar), and a test of syntactic ambiguity resolution, adapted from Trueswell et al (1999) [3]. Participants heard ambiguous and unambiguous sentences (Ambiguity Condition) (e.g. “put the frog [that’s] on the napkin in the box”) while looking at a display containing relevant images, including either 1 or 2 referents for the first noun (Reference Condition).

Preliminary results ($n = 37$; 20 monolingual; 17 bilingual matched for age, nonverbal IQ and SES) confirm that monolinguals show higher scores on receptive vocabulary ($p < 0.05$) and grammar ($p = 0.05$). Despite robust differences between conflict and non-conflict trials, we found no bilingual EF advantage in any of the four EF tasks. Gaze data demonstrates that bilingual children make better use of contextual information. Specifically, in the 2-Referent Ambiguous condition, bilinguals, but not monolinguals, interpret the ambiguous phrase, on the napkin, as a modifier of the object, frog. Specifically, upon hearing the noun (frog), bilinguals look significantly more to the target animal (frog on the napkin), while monolinguals look equally at both the target and non-target animals ($p < 0.05$). However, monolingual and bilingual participants do not differ in their actions, producing similar numbers of garden-path errors.

Bilingual children show better use of top-down information, despite weaker English language skills. However, the bilingual's advantage in sentence comprehension is unlikely to reflect differences in EF, since both groups performed equally on all EF measures. We suggest that bilingual children, over the course of language acquisition, may need to rely more on contextual information making them more aware of how language is influenced by context.

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32. Context-dependent bilingual advantages: Roles of language and working memory

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Child development; Bilingualism; Task-switching; Working memory; Semantic processing; Cross-modality cueing

Previous research concerning bilingual and monolingual differences is inconsistent in findings of bilingual advantages across different types of cognitive control (CC) tasks ⁽¹⁾. Certain studies indicate that differences in CC occur solely due to working memory (WM) ability, not bilingualism ⁽²⁾, while others maintain that the bilingual experience provides a specific advantage to CC beyond other influences ⁽³⁾. Advantages found in bilingual CC are attributed to language-specific processes, including attention, inhibition, and switching in multiple languages ⁽⁴⁾. Thus, these advantages may be affected by CC tasks that provide different amounts of language information. The goals of the current research are (1) Examine CC differences in monolingual and bilingual children receiving varied on-line language input within a task; and (2) Identify relationships of verbal and nonverbal WM with CC as language input varies.

The current study varied language input by manipulating the Semantic, Visual, and Auditory content in four conditions of the Dimensional Change Card Sort (DCCS; ⁵), which has demonstrated a robust bilingual advantage in many previous studies ⁽⁶⁾: *Nonsemantic* (Shape/Color sorting), *Visual-Semantic* (Kind/Color sorting with pictures of foods and animals), *Auditory-Semantic* (Kind/Color sorting with spoken names), and *Both-Semantic* Visual and Auditory (Kind/Color with pictures and names). Verbal and Spatial WM were also tested to examine alternative explanations for bilingual differences. We tested 26 4-5 year old children, who tend to have difficulty with switching between sorting types (e.g., Shape/Color) in a mixed block. Importantly, this age group has primarily had language input in the auditory domain, so auditory information is particularly important to the development of any bilingual advantages up to this point. We hypothesized that (1) Task-specific language input will interact with bilingualism: Bilinguals will show the greatest CC advantage when given only verbal information; and (2) Verbal and non-verbal WM will predict CC only for tasks that involve the same domain.

Results showed a bilingual advantage in switching costs between incongruent and congruent trials. However, this occurred due to higher monolingual accuracy on congruent trials, not any bilingual advantage on incongruent trials. Language-input condition predicted accuracy on congruent trials: children were more accurate on Visual- and Auditory-Semantic conditions compared to Both-Semantic and Nonsemantic conditions.

Verbal WM predicted higher accuracy for congruent trials. Spatial WM interacted with Language-input condition for reaction time (RT) on incongruent trials, but not on congruent trials, when testing only accurate trials; Spatial WM also interacted with DCCS condition for RT trial switch cost when all trials were included; Better spatial WM predicted slower incongruent RT and larger RT costs for the Nonsemantic condition, but not for any of the three Semantic (language-based) conditions.

Implications are discussed in terms of understanding mechanisms of bilingual differences and relationships between language, cognitive control, and working memory.

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33. Language control and nonlinguistic shifting skills in bilingual children

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Language control; Cross-language errors; Task-shifting; Mixing costs; Switching costs; Executive function; Child bilingualism; English-Spanish; Picture naming

To communicate effectively with a variety of conversation partners, bilinguals must develop *language control*, the ability to adjust their language choice based on the situation. This ability to switch between languages and control interference from the language-not-in-use has been associated with task-shifting in adult bilinguals (e.g., Prior & Gollan, 2011). However, it remains unclear at what level of lexical selection domain-general task-shifting skills may be recruited for language control. The goal of the current study was to examine the relationship between the shifting component of executive function and language control, as measured at different levels, in bilingual children.

The study included 68 English-Spanish bilingual children, ages 5-7. Language control was assessed with a timed picture-naming paradigm. Children named pictures in English or Spanish, according to an auditory cue, in a single-language context (English-only; Spanish-only) and a mixed-language context in which the cued language varied unpredictably. Language control was measured at two levels. *Cross-language errors*, when children responded in the opposite language from the cue, indicated a failure of language control. For correct responses, increased *naming latency* indexed how taxing it was for children to successfully exert language control. At both levels, two kinds of costs were assessed: *mixing costs* (performance in a mixed-language vs. single-language context) and *switching costs* (performance when switching languages vs. staying in the same language during the mixed condition). The shifting component of executive function was measured with the Dimensional Change Card Sort (DCCS; Zelazo, 2006). The DCCS required children to sort colored squares and circles first by color, then by shape, and then to switch between sorting rules during a mixed phase. Accuracy during the mixed phase indexed shifting.

Mixed-effects analyses of cross-language errors revealed both mixing costs ($\beta=2.30$, $t=2.81$), and switching costs ($\beta=1.08$, $t=2.56$). Children were more likely to make cross-language errors in a mixed-language than a single-language context, and within the mixed context they were more likely to make cross-language errors when they were cued to switch languages. Children with better shifting (DCCS performance) were less likely to produce cross-language errors overall ($\beta=-0.056$, $z=-5.48$); this effect did not vary by context or switch status. Naming latency analyses revealed significant mixing costs ($\beta=0.19$, $t=6.64$) but no significant switching costs. The effect of DCCS performance on naming speed was modulated by an interaction with context ($\beta=0.003$, $t=1.97$), with a significant effect of DCCS in the single-language but not the mixed-language context. DCCS performance did not explain any additional variance in the switch-cost analysis of the mixed-language condition.

Together, these findings suggest that nonlinguistic shifting skills contribute to language control at the level of selecting the correct language. Once the correct language is selected, more nuanced costs in speed may be localized to the language system.

34. Efficiency of Inhibitory Control in Second Language Learners – insight from a behavioral and ERP longitudinal study

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Inhibitory control; Language learning; Immersion; Bilingual advantage;

Previous studies suggest that bilinguals outperform monolinguals in conflict resolution tasks, indicating a bilingual advantage in inhibitory control [1,2]. However, it is unknown whether there is a causal relationship between bilingualism and the efficiency of inhibitory control mechanism. Until now, a bilingual advantage in inhibitory control has been tested only in cross-sectional studies, which allow to establish a correlation, but not causal relationship. Provided there is a causal link between bilingualism and inhibitory control, the more individuals are exposed to a foreign language, the more efficient their inhibitory control should be [5].

In the present study we tested whether the efficiency of inhibitory control improves as a consequence of foreign language training. We compared performance of two groups of participants in the Eriksen Flanker task, in a longitudinal design. The experimental group consisted of 27 Polish students who were enrolled in a partial immersion English program at high school. The control group consisted of 31 Polish high school students learning English only as a foreign language. The LexTALE test was used to collect information on participants' language proficiency. Both groups were tested three times, with at least 7-month breaks between the testing sessions.

In each testing session we collected behavioral and ERP data. We measured a magnitude of the flanker effect (incongruent minus congruent condition) in RTs and error rates. If intensive language training improves the inhibitory control, we should observe a reduction in the magnitude of the flanker effect across the testing sessions in the experimental group, but to a lesser extent in the control group. Within the ERPs we were interested in the mean amplitude of the N2 component. This early negativity increases in the amplitude with increased inhibitory control demands (with incongruent trials in the Eriksen Flanker Task). If intensive language training improves the inhibitory control, we should observe differences in the N2 effect between the groups and sessions. The behavioral data showed a significant flanker effect in all three testing sessions (RTs $p < .001$; accuracy $p < .001$). The flanker effect was more prominent in the first testing session, compared to the second and third sessions ($p < .001$). Although the flanker effect changed across the testing sessions, the magnitude of reduction was the same for both groups. ERP data revealed a frontal positivity for incongruent trials followed by P3b component, but there were no differences between the groups and between the sessions. Taken together, the present data probably reflects age-related cognitive development, rather than the development of inhibitory control induced by intensive training in the L2. The data will be discussed in the light of the ongoing debate about bilingual benefits in inhibitory control domain.

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35. Attention networks functioning in bilingual children: evidence from Polish-English migrant children living in the UK

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Executive control; Alerting; Orienting; Bilingual children; Polish English; Attention Network Test; Flanker effect; Early bilingualism

Some studies demonstrate that bilingual children outperform their monolingual peers in overall reaction time and accuracy in attention tasks (Yang and Lust, 2011; Bialystok, et al. 2012), demonstrate a particular advantage in the ability to resolve conflict (Engel de Abreu et al., 2012) and benefit more from a spatial cue which helps to align attention more efficiently (Poarch and Van Hell, 2012).

In the reported study we focus on the comparison between the group of Polish migrant children living in the UK and their peers living in Poland on child friendly version of the Attention Network Test (Rueda, 2004). The task allows to evaluate the three separate attention networks' processing efficiency (Fan et al., 2002) measuring conflict resolution, alertness and orienting of attention.

In the task, a stimuli (fish) appears in a horizontal line at the center of the laptop screen. The child's task is to decide whether the fish in the middle (stimuli) is pointing to the right or to the left. Four other fish in a line (the flankers) are pointing either to the same direction as the stimuli (congruent condition) or to the opposite direction (incongruent condition). Before the stimuli appears on the screen, a child is presented with one of four different cue types: double, spatial, center and no cue. The task is divided into four blocks, 32 trials in each (50% incongruent) and lasts approximately 20 minutes. Both reaction time and accuracy are measured. In between-group comparisons we compare: (a) the difference between congruent and incongruent trials in reaction time and in accuracy (flanker effect), (b) the difference between center cue and spatial cue condition (orienting network), (c) the difference between no cue and double cue condition (alerting network) as well as (d) the mean reaction time and (e) the mean accuracy.

Preliminary comparison of a group living in the UK (N=38) and Poland (N=39), matched for age and SES, reveals that monolingual group enjoys smaller flanker effect in accuracy than their bilingual counterparts ($F(3,73)=6.33$, $p=.014$, $\eta^2=.780$) and benefits more from the alerting cue ($F(3,72)=4.71$, $p=.005$, $\eta^2=.164$). Subsequent analyses will involve analyzing possible factors that might have contributed to the absence of the expected benefit in cognitive control in the migrant children group. Factors such as experimental setting (home vs. school) will be taken into account in the follow up analyses. The additional analyses will involve testing a relationship between the size of the flanker effect, the proficiency in both languages as well as the length of exposure to L2. A limited input in both languages, and thus no sufficient training in using both languages, might be a factor driving the lack of the expected benefit in attention functioning of the emerging bilingual group.

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36. Development of L2 language proficiency, cross-language interaction, and executive functions in child L2 learners, bilinguals, and trilinguals: Parallel development trajectories?

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Executive functions; Simon task; ANT; Bilinguals; Trilinguals; Second language learners; Cross-language activation

This talk combines two studies on cross-language interaction and executive functions in child L2 learners, and bilingual and multilingual children (1,2) and builds empirically on the emerging data on cross-language interaction during lexical access in adult bilinguals (e.g., 3, 4) and findings of enhanced cognitive functions in conflict resolution tasks (Simon Task; Attentional Networks Task) in child bilinguals compared to monolinguals (e.g., 5, 6, 7). In Study 1, using a picture naming paradigm with cognate manipulation, a bidirectional cognate facilitation effect was found in bilinguals and trilinguals but not in child L2 learners, in whom only the stronger L1 influenced the weaker L2. In Study 2, the Simon effect advantage differed across groups with bilinguals and trilinguals showing enhanced conflict resolution over monolinguals and marginally so over second language learners. In the ANT, the bilinguals and trilinguals displayed enhanced conflict resolution over second language learners. As enhanced executive functions in bilingual children are assumed to stem from their permanent need to monitor, control, and shift between two languages, and that bidirectional cross-language activation is modulated by relative language proficiency and use, one may assume that both cross-language activation and cognitive control develop in parallel along the same trajectory. Thus viewed together, the results of both studies may indicate parallel development of relative language proficiency and corresponding cross-language activation, on the one hand, and an enhanced development of executive functions, on the other hand.

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37. The role of inhibitory control in cross-language priming

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Inhibitory control; Cross-language priming; English; Norwegian; Bilingual children; Dative alternation

The present paper investigates the relationship between cross-language structural priming and inhibitory control in bilingual children. Previous research has employed structural priming to demonstrate that abstract syntactic representations can be shared between two languages, provided that they are sufficiently similar (see Loebell & Bock 2003; Hartsuiker, Pickering & Veltkamp 2004). The dative constructions in English and Norwegian meet this criterion, as shown in (1) and (2)

- (1) The dog shows the queen the book
 Hunden viser dronningen boka
- (2) The dog shows the book to the queen
 Hunden viser boka til dronningen

The presence of structural priming in bilingual settings indicates that the shared abstract syntactic representations stay active for a certain amount of time after having been experienced in one language, effectively influencing subsequent production and comprehension in the other.

Bilingual individuals need a mechanism to control attention to the language they are using while avoiding interference from the other one. This mechanism is commonly referred to as inhibitory control, and it is thought to be involved in both linguistic and other cognitive processes. A yet unexplored issue is how inhibitory control works on the shared representations during structural priming and specifically, whether it somehow weakens their active state.

In this paper, I tested Norwegian-English bilingual children on dative alternation in within-language and between-language contexts and compared the strength of the effect. In addition, the same speakers were given a classical executive function task, the Dimensional Change Card Sort (DCCS), in order to establish whether there was a correlation between performance on the executive function and priming tasks. I predicted that those children who score better at the DCCS, i.e. those with a higher inhibitory control, should also display a weaker priming effect. This hypothesis makes the assumption that the kind of inhibition associated with cognitive tasks is the same as that involved in the linguistic processes underlying the access to the shared representations of a bilingual grammar.

Results showed that within-language priming is significantly stronger than between-language priming, suggesting that inhibition is indeed at work for the duration of the task. However, there was no correlation between priming and the DCCS score. I therefore suggest that the kind of inhibition involved in priming and in cognitive tasks are not identical. Specifically, I propose that there might exist a ‘strictly linguistic’ inhibitory control that is not necessarily related to broader cognitive abilities.

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38. Identifying Specific Language Impairment in Bilingual Children: Are Executive Function Tasks Discriminating?

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Bilingualism; Specific Language Impairment; Executive Function; Assessment.

The number of schoolchildren in France growing up with French and another language is constantly increasing; yet identifying Specific Language Impairment (SLI) in these children remains very difficult. In fact, French speech and language pathologists are generally not capable of assessing the first language of these children and disentangling language deficits due to SLI from difficulties related to typical L2 acquisition is often very complicated. Studies comparing children with SLI and L2 children have revealed important similarities in linguistic performance ([6] [13], a.o.). These similarities often lead to misdiagnosis. One possible direction for identifying SLI in bilingual children is assessing their nonlinguistic ability. Previous studies suggest in fact that children with SLI show deficits in some Executive Functions (EF) such as attention, inhibition, shifting and working memory (WM) ([10] [7] [9], see [11] for a review). In the present study, we compare Bilingual children with SLI (Bi-SLI) and Bilingual Typically Developing children (Bi-TD) on WM (visuo-spatial short term memory, complex working memory and verbal short term memory), selective attention, inhibition and shifting tasks. Language and executive function tasks were administered to Turkish-French and Portuguese-French children aged 5;6 to 8;11 years. Results from 20 Bi-TD children and 10 Bi-SLI children, L1 Turkish or Portuguese and L2 French, (data from 22 other children are currently being processed) reveal lower performance in Bi-SLI children on WM and in particular on verbal short-term memory which was significantly correlated to language measures. However, none of the nonverbal tasks distinguished the groups, although these same tasks were shown to be discriminating in a previous study [8]. No difference was found between the Turkish-French and the Portuguese-French children on any EF tasks.

These results confirm those obtained in previous studies showing verbal short-term memory deficits in children with SLI ([1] [2]; a.o.). They fail however to support the hypothesis of nonverbal WM and EF deficits in Bi-SLI children. This latter result does not contradict however the hypothesis of subtle nonverbal deficits in Monolingual SLI children (see [11]) as it may be explained by the hypothesis of enhanced WM and EF in bilinguals ([3] [4] [5] [8] [12], a.o.). Bilingualism may have boosted the nonverbal abilities of children with SLI, reducing the gap between their performance and performance of Bi-TD children.

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39. Executive Functioning in Bilingual Children with ASD: Are there advantages of being bilingual?

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Bilingualism; Autism Spectrum Disorders; Executive Functioning; Set-shifting skills; English-French-Spanish

While many studies have examined the impact of bilingualism on Executive Functions (EF) in typically-developing children, few have investigated a neurodevelopmental disorder with known EF impairments. If a bilingual advantage exists (Bialystok & Martin, 2004; Bialystok & Viswanathan, 2009), it might mitigate executive dysfunction in such a case. Children with Autism Spectrum Disorders (ASD) demonstrate EF impairments, specifically, they tend to exhibit perseverative responses on set-shifting tasks (e.g., Ozonoff et al., 2004). Conversely, they are not impaired in short-term memory (e.g., Boucher et al., 2012; Zinke et al., 2010). We examine the impact of bilingualism on EF in ASD with a special interest in set-shifting abilities. We hypothesized that bilingual children with ASD would be impaired in set-shifting relative to bilingual typically-developing (TYP) children, but would be less impaired than monolinguals with ASD (biTYP> biASD> monoASD). As a control we hypothesized that short-term memory would not differ between groups.

Bilingual TYP, bilingual ASD, and monolingual ASD groups were matched pairwise on nonverbal IQ and age. The target sample includes 20 biTYP, 15 biASD, and 15 monoASD 5- to 9-year-olds. Participants include French, Spanish or English speakers (or speakers of any 2 of these languages). We examined EF via parental report on the Behavior Rating Inventory of Executive Functioning (BRIEF; Gioia et al., 1996). To evaluate set-shifting we used a computerized version of the Dimensional Change Card Sort task (DCCS; Zelazo, 2006). Short-term memory was assessed by the number repetition subtest of the Clinical Evaluation of Language Fundamentals (CELF-4; Semel et al., 2003).

Preliminary data is available from 7 biTYP, 7 biASD, and 7 monoASD children. Findings generally pattern in line with our predictions. There was a significant difference between groups for the General Executive Composite Score of the BRIEF (lower scores = higher functioning: biTYP $M = 46$; biASD $M = 58$; monoASD $M = 65$; $p = .008$). Post-hoc tests revealed that the Bilingual TYP and Monolingual ASD groups were significantly different ($p = .007$), whereas the Monolingual and Bilingual ASD groups ($p = .56$) and Bilingual TYP and Bilingual ASD groups ($p = .12$) were not. The same pattern was found for the shifting sub-scale.

On the DCCS task a “pass” is correctly answering 5 of 6 post-switch trials. The percentage of children passing the post-switch phase was: biTYP= 100%; biASD= 86%; monoASD = 57%. This difference did not reach significance ($p=.08$), nor did a measure of switch cost on response time. Finally, short-term memory was not significantly different across groups.

Data collection is ongoing and will allow us to investigate in a larger sample if executive function difficulties, particularly in set-shifting ability, experienced by monolinguals with ASD are significantly reduced in bilinguals with ASD.

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40. Investigating a working memory advantage in bilingual Arabic-English children

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Bilingual children; Working memory; Verbal and visuospatial short-term

Bilingual children who are living in a multilingual environment need to switch between two languages on a regular basis in their everyday lives. During speech production, bilingual speakers activate both language systems equally in their mind. To activate the relevant language and suppress the non-target language, bilinguals use a mechanism of cognitive control. The constant use of cognitive control in bilingual children may aid their performance on tasks that rely on this particular mechanism. Indeed, bilingual speakers have been found to outperform their monolingual peers on several tasks of executive control.

Working memory is an important resource that has been linked to cognitive control. The working memory system supports the short-term storage of verbal and visuospatial material, and updates and manipulates information held in the short-term stores. The ability to hold relevant information in mind may be considered an important component of cognitive control. In related work, intensive working memory training has been found to result in improved working memory functioning. The idea that bilingual children exercise cognitive control (along with working memory updating) to a greater extent than their monolingual peers gives rise to an expectation of a cognitive control (and possibly working memory) advantage for bilingual groups.

In order to examine this hypothesis, 54 bilingual children ages 6 to 9 years whose L1 was Arabic and who had been learning English as the language of instruction (L2-English) in Canada and 376 TD Arabic-speaking children from Saudi Arabia of similar age completed measures of verbal and visuospatial short-term and working memory in their dominant language. Results revealed no significant differences between bilingual and monolingual children on composite domain-specific short-term and domain-general working memory measures. As such, the study provides no evidence for a bilingual advantage related to the working memory component of cognitive control. One possible explanation may be related to the context in which our bilingual speakers were immersed. That is, the demands for English and Arabic in the Canadian environment were often separated, for example, as the home or school language. As a result, the demands for cognitive control in activating the relevant language might have been reduced in these speakers. Alternatively, it may be that the bilingual benefit of constantly exercising cognitive control impacts processing resources other than working memory updating and not measured in our study.

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41. Does the ‘bilingual advantage’ appear in immersion education after sufficient exposure?

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Bilingualism- executive functions- immersion education- Simon Task

Background:

Some studies have shown that ‘full’ bilingualism might enhance the executive functions in children, young adults and elderly people. The present study aimed at investigating whether similar effects could be found in children learning their second language at school in immersion education programs. Moreover, since one study suggested that the duration of immersion training might be an important element in the emergence of this ‘bilingual advantage’ in immersion learners, children with sufficient immersion training were tested in this present study.

Methods:

44 children involved in immersion education for 4 to 5 years were compared to 48 children in traditional schools. All children were between 9 and 11 years old. To assess executive functions, the Simon Task was used, a neuropsychological measure assessing executive functions with reaction times and accuracy on congruent and incongruent trials. To control for background measures, all children underwent the Raven’s Coloured Progressive Matrices, to measure non-verbal intelligence and the Echelle de Vocabulaire en Images Peabody (EVIP), assessing verbal intelligence. In addition, a questionnaire was given to the parents to control for other confounding variables, such as socio-economic status (SES), home language, developmental disorders, etc.

Results:

There were no significant differences between groups concerning non-verbal intelligence and verbal intelligence. Furthermore, the immersion learners showed overall faster reaction times on both congruent and incongruent trials compared to the traditional learners, but only after 5 years of training, not before.

Conclusion:

These results suggest that the advantage found in ‘full’ bilinguals might also appear in children involved in immersion education, but only after a sufficient exposure to the second language. However, future longitudinal or semi-experimental studies will need to confirm this.

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42. Metalinguistic Abilities and EF in Young Foreign Language Learners. Preschoolers in FL immersion may benefit more strongly from repeated testing.

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metalinguistic ability; executive function; partial bilingualism; emerging bilingualism; child L2 learning; early immersion

An ever-growing body of research has shown that individuals who know more than one language use, process, store, and understand language(s) differently from those who know only one. For instance, compared to their monolingual peers, bi/multilingual children often demonstrate a more abstract and advanced understanding of what language is and how it works in areas such as word-meaning connection or morphology. They also show more domain-general cognitive benefits, performing better on certain tasks of executive function (EF) and cognitive control, even when these are non-linguistic in nature (for an overview, see e.g. Bialystok, 2009; Bialystok, Craik, Green, & Gollan, 2009). However, most such studies have focused on children who are fairly proficient rather than partial/emerging bilinguals, and only very few studies have looked at the development of these abilities over time.

The present study included some 100 children from German-speaking families, about half of whom were in regular German-language kindergartens (ML or monolinguals), and half of whom attended kindergartens with some form of intensive English immersion or bilingual program (YLL or young language learners) and can therefore be considered emerging bilinguals. The majority entered the project around age 4-5 and were tested three times over a period of two years, but some were tested only once at age 6, in the children's final months of pre-school.

Tests of EF and metalinguistic abilities found no significant performance differences between the once-tested ML and YLL, but in the longitudinal cohort, the YLL were showing some performance advantages over the ML by their third and final test time. A comparison of test results between the 'first-timers'/'novices' and the 'third-timers'/'repeaters' at age 6 yielded interesting results. That children doing a task for the third time should perform better than a child of the same age doing it for the first time will come as no surprise. However, while there were no significant differences between 'novices' and 'repeaters' among the monolinguals at age 6, among the young language learners, the 'repeaters' scored significantly higher than the YLL 'novices' on a test of nonverbal executive function, a metalinguistic task that depended highly on control of attention and inhibition, and a test of morphological awareness. In other words the young language learners may have benefitted more from repeated testing (practice effect) than the monolinguals.

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43. Mixed Language Use and Cognitive Flexibility in Young Bilinguals

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Cognitive flexibility; Executive function; Spanish-English bilinguals; Home language use; Trails task

In recent decades, US public school classrooms have become increasingly diverse, both linguistically and culturally [1]. While English is the primary medium of instruction in U.S. schools, many children have diverse language experience outside of school. Traditional group comparison may not capture the heterogeneity in bilingual groups [2]. We examined variability in home language usage and executive functions (EF) in children. We expected (1) no group difference in EF between monolinguals and broadly defined bilinguals; (2) differential outcomes in EF between bilingual subgroups with different proportions of bilingual home language use.

Eighty-five (85) monolingual and bilingual fourth-grade children (female=45) between the ages of 10-13 yrs. ($m=11.01$) attending public elementary schools participated in both a home language survey and an individual task battery as part of a larger study of reading and EF. Parents completed a detailed questionnaire about children's daily language use and home language environment. Non-English language use at home was coded as a polynomial treatment factor using quartiles of non-English language use at home (i.e. 0%, 25%, 50%, 75%, and 100% of other language use). Children completed an experimental EF task, Trail-making. Cost of switching, a measure of cognitive flexibility, was computed by subtracting accuracy on the non-switching (number only) trials from switching (letter-number) trials of this task.

Our sample, particularly the bilinguals, had heterogeneous demographic backgrounds: groups with differences in non-English language use also displayed significant differences in maternal education ($F(9,75)=2.62, p= 0.011$). We therefore conducted analyses with both non-matching and matching multinomial propensity scores to reduce covariate effects. First, when monolinguals and bilinguals were compared as dichotomous groups without distinguishing proportions of non-English language usage at home, no significant differences between groups emerged, both before ($b=-0.10, s.e.=0.07, t=-1.41, p=0.164$) and after binomial covariate matching ($b=-0.05, s.e.=0.07, 95\% C.I.: [-0.1990, 0.0984]$). Then, we considered the bilinguals divided into five subgroups based on proportion of non-English language use at home. A polynomial regression model revealed that individuals who spoke a more balanced mixture of languages at home (e.g. 50% English and 50% another language) incurred lower switching costs in accuracy, while children who spoke more of only one language at home (e.g. 100% English or 100% another language) displayed greater switching costs ($R^2= 0.13, F=2.91, p=.02$). After covariate rebalancing, a propensity score-weighted model continued to find a significant effect of home language group with the balanced home language group (50% English) showing the lowest cost of switching ($b=-0.21, s.e.=0.06, t =-3.52, p<0.001$).

Results suggest a multidimensional, rather than categorical, characterization of bilingual language use can aid in understanding the allocation of cognitive resources during childhood. Proportion of language use, a dimension of bilingual experience, may interact with EF development, creating distinct cognitive profiles that affect classroom learning.

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44. Dual Language Proficiency and Self-Regulation as Predictors of Academic Performance of Latino Children of Immigrants

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The present study investigates the roles of Spanish and English proficiencies and self-regulation, including executive functioning, on the academic performance of Latino children of immigrants in the early school years. Language competences and executive functioning such as the capacity to organize and process information, the flexibility to shift attention, skills related to problem solving, and inhibitory control are closely connected to completing academic tasks and functioning well in school contexts [1]. Within the academic environment, children who understand more complex language are better equipped to comply with the demands of school [2]. In contrast, children who have difficulty expressing ideas and understanding others are likely to face challenges controlling their attention and behavior when attempting to learn and focus in the classroom [3]. Given the evidence among the general population of the relationship between children's executive functioning and language skills and implications for children's academic success, it is critical to investigate the more complex case of dual language (bilingual) Latino children of immigrants. Dual language children from Spanish speaking low-income families have been evidenced to begin school with wide range language abilities in each language [4]. It is important to understand how high the variability of Spanish and English proficiencies of these children at school entry affects their executive functioning and school success.

This longitudinal study of second-generation immigrant children (n= 228) includes multi-dimensional data collected from direct child assessments, parent interviews, classroom observations, and teacher reports. Latino children of immigrants who were born in the US and were first language speakers of Spanish were recruited at kindergarten (mean age=6) from 15 public schools and followed 2 years later (mean age=8) at more than 25 schools, with 80% retention. Children were directly assessed using the following measures: 1) Dual language proficiency: Woodcock Language Proficiency Batteries-Revised (WLPB-R) 2) Working memory (including auditory/verbal): Comprehensive Test of Phonological Processing 3) Executive functioning (including visuo-spatial): Universal Nonverbal Intelligence Test, and 4) Academic performance including literacy skills (WLPB-R), and teacher reports of school functioning.

Hierarchical multiple regression models were used to analyze associations of dual language proficiencies and academic outcomes, and the role of executive functioning. Models controlled for demographics and kindergarten academic levels to examine residualized change. Spanish and English proficiency significantly predicted academic performance at 2nd grade ($R^2s=.13-.39$; $p <.000$) as well as executive functioning ($R^2s=.08-.21$; $p <.000$). In separate models, executive functioning also predicted academic performance ($R^2s=.15-.36$; $p <.000$) yet when considering all predictors in one model, Spanish and English proficiency remained a significant predictor of academic performance while executive functioning did not, indicating a mediation effect of executive functioning through language proficiency. Methods, findings and conclusions will be presented.

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45. More distributed neural networks for bilinguals than monolinguals during switching

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bilingualism; task-switching; language switching; event-related potentials (ERPs); mixing cost; switching cost

During task-switching bilinguals outperform monolinguals due to their experience with continuous language-switching. This behavioral advantage is not always present in young adults due to ceiling performance. The present study investigated the underlying processing differences between monolinguals (English) and bilinguals (English-French) during possible similar performance. Further, the underlying mechanisms of task-switching are compared to language-switching with electrophysiological (EEG) measures. Both groups performed a domain general (task-) and language-switching task including blocks with one task (pure) and blocks with two tasks (mix), where the task could be repeated or switched. During task-switching monolinguals and bilinguals demonstrated same mixing (pure vs. mix) and switching (repeat vs. switch) costs. However, within the mixed blocks bilinguals were more accurate than monolinguals. The same behavioral mixing cost was reflected in a more distributed neural network for bilinguals. The same behavioral switching cost revealed earlier processing differences for bilinguals (275 ms) than monolinguals (325 ms). These processing differences could explain the enhanced performance during the mixed blocks. This was supported by the language-switching task that also revealed more distributed networks for bilinguals than monolinguals for the switch cost and additional late (350-400 ms) executive control for monolinguals compared to bilinguals for the mixing cost. Thus, the more distributed networks for bilinguals suggest the integration of verbal and non-verbal control networks during early visual processing (125-175 ms) and later executive processing (225-275 and 325-375 ms).

46. The origin of the bilingual advantage in false-belief reasoning

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Theory of Mind; false-belief tasks; true-belief inhibition; attentional processes; eye-tracking

In the Sally-Anne task – a standard measure of Theory of Mind development, Sally puts a marble in a box before going out to play. During her absence, Anne moves the marble to a basket, setting the scene for the false-belief question: ‘When Sally comes back, where will she look for her marble?’ [1]. Children under 4 err by predicting that Sally will look for her marble in the basket, rather than in the box where she left it. This paper investigates the origin of the bilingual advantage that has been found in false-belief reasoning relative to monolinguals, both in children [2, 3] and in adults [4].

Recent Theory of Mind studies with monolingual children show that 3-year olds’ focus of attention in standard false-belief tasks is critical for their performance. That is, when 3-year olds are allowed to focus on the protagonist throughout the narrative and the false-belief question doesn’t draw their attention to the target object (hence increasing the salience of the wrong response) they are able to pass standard false-belief tasks [5, 6]. In view of these recent results and contrary to the traditional view that young children fail standard false-belief tasks because they are unable to inhibit their own knowledge of the location of the object [see, e.g., 7], I have argued that this bias is task induced and that passing false-belief tasks only requires inhibiting one’s own knowledge if the task disrupts the participant’s focus of attention on the protagonist and draws their attention to the object [6, 8].

Following the traditional view, it had previously been assumed that the bilingual advantage in false-belief reasoning was due to the bilinguals’ increased Executive Control [see, e.g., 4]; that is, bilingual children and adults were better at inhibiting their own knowledge of the location of the object when responding to a false-belief question. However, under the competing assumption that false-belief reasoning doesn’t necessarily involve inhibition of one’s own knowledge, it remains to be explained what’s the origin of the bilingual advantage in false-belief reasoning. In this paper I will propose that this advantage is related to the bilinguals’ better use of attentional resources, in line with a recent proposal by Ellen Bialystok on the origin of the cognitive benefits of bilingualism [9, 10]. I will illustrate this view with the results of two eye-tracking studies on false-belief reasoning in adults, one with bilinguals and monolinguals [4] and another one with monolinguals [11].

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