The Bilingual Advantage
The Impact of Language Learning on Mind & Brain

POSITION PAPER ON THE VALUE AND FUTURE OF LANGUAGE EDUCATION

EduCluster Finland
University of Jyväskylä Group
Finland

Citation: Marsh D., Díaz-Pérez, W., Frigols Martín, M.J., Langé, G., Pavón Vázquez, V., Trindade, C. (2020) The Bilingual Advantage: The Impact of Language Learning on Mind & Brain. Jyväskylä: EduCluster Finland, University of Jyväskylä Group.

Correspondence concerning this Position Paper should be addressed to:
david.marsh@educluster.fi or dm@davidmarsh.education

ISBN 978-952-94-3995-9
First published: 2020

Publisher: EduCluster Finland, University of Jyväskylä Group, Finland

Overview

There is evidence that people who have more than one language have advantages over monolinguals. This paper describes six ways in which advantage is realized through the impact of having more than one language in the mind and brain. It also describes why successful language learning depends on educational practices that combine opportunities to learn language as a subject, and to learn content through language.

The scientific evidence-base on languages, mind and brain has expanded in the last decade. This science provides insights on the design of educational practices. One of these is to re-think the teaching of languages as separate subjects. Another is to consider providing small-scale opportunities for young people to learn through an additional language.

This paper provides a succinct summary of the key issues involved in understanding the scope of the case for language education. It argues that knowledge of more than one language, even if partial, can provide people with advantages not accessible to monolinguals.

How to Navigate this Paper

1. **Learning in the 21st Century: what is essential now**
   Systems thinking as an essential competence
2. **Language Learning for the 21st Century: what we now know**
   Effective language learning pathways
3. **The Bilingual Advantage for Mind & Brain: what we should know**
   Six advantages for people who can think in more than one language
4. **Education in the 21st Century: what we should do**
   The case for achieving advantage through bilingual education practices

Caveat:

- This position paper condenses complex theory and research to provide the reader with an accessible summary. References of key research publications are collated in single form. Footnotes provide further explanation of key terminology. The comprehensive research report is due for 2021.
- This paper is an updated reformulation of a meta-analysis report originally produced for the European Commission in 2009, *Multilingualism and Creativity: Towards an Evidence-base, in The Contribution of Multilingualism to Creativity.*
- The term bilingual is subject to differing definitions. In this paper the term bilingual is used to refer to *an individual who frequently uses two or more languages or language varieties with greater or lesser fluency.*
- The multi-faceted nature of variables in research on education, mind and brain require constant vigilance in research interpretation. There is potential for research in this field to be subject to the influence of social or political forces which can lead to undue influence on research design and interpretation. Generalization of results needs to be managed with caution when considering replicability of research findings from one context to another.

1. Learning in the 21st Century: what is essential now

One aim of education is to develop **global competences.**[1]

Global competences depend on cultivating **systems thinking.**[2]

Systems thinking relates to an ability to engage **fluid intelligence.**[3]

Fluid intelligence is linked to **creativity & innovation.**[4]

Global competences also depend on **crystallized intelligence.**[5]

Educational curricula have tended to value the cultivation of knowledge-building and the evaluation of crystallized intelligence through **standardized tests.**[6]

The value in developing crystallized intelligence remains high, but in the information-rich digital age having competences in fluid intelligence has become essential.

There is commonly not enough focus on developing fluid intelligence in education, with most attention given to teaching and testing of crystallized intelligence.

Enabling education to be fit-for-purpose in the present day requires focus on provision of opportunities for developing both crystallized and fluid intelligences. This can lead to development of global competences and **deep learning.**[7]

1. **Global Competences:** knowledge and understanding of global issues, skills for analytical and critical thinking, attitudes such as openness and respect towards other people, and values appraising human dignity and cultural diversity (see OECD PISA).
   knowledge, skills, attitudes & values
2. **Systems Thinking:** seeing patterns and inter-dependency of how one thing is related to and influences another (see Donald Hebb).
   'neurons that fire together, wire together'
3. **Fluid intelligence:** the capacity to think logically, identify patterns and relationships, to be reactive and proactive in understanding features and processes in new and emergent situations with and without dependency on prior knowledge. Colloquially it can be thought of as adaptive knowledge and skills (see Raymond Cattell).
   ability to reason speedily and abstractly
4. **Creativity & Innovation:** terms frequently understood differently within and across languages and cultures. Creativity relates to imaginative activity envisioning a new system, a new way of doing things. Innovation relates to realizing a new system, a new way of doing things.
   creativity generally precedes innovation
5. **Crystallized Intelligence:** ability to make deductions in developing secondary relational abstractions by drawing on primary relational abstractions - what a person has already learnt as prior knowledge (see Raymond Cattell).
   encyclopaedic knowledge and skills
6. **Standardized Tests:** questions, time allocated for answering, scoring procedures, and interpretations of right and wrong are generally managed in a single consistent way.
   standardized tests suit standardized minds
7. **Deep Learning:** combination of crystallized and fluid intelligences which builds complex understanding and meaning.
   the locus of value creation

2. Language Learning for the 21st Century: what we now know

Successful language learning requires opportunities for both language acquisition and language learning. This is the basis of the **acquisition-learning hypothesis.**[8]

Acquisition is often sub-conscious where the learner may not realize that it is happening. We acquire language when we understand and engage with content. This is the basis of the **comprehension hypothesis.**[9]

A widely discredited counter hypothesis is the **maximum exposure hypothesis.**[10] This suggests that exposure alone enables people to successfully learn a language.

Learning words, rules and grammar in a language lesson involves a conscious process. This often fails to work because what is being learned is detached from meaningful content. This type of pedagogy is against the principles of innate language learning ability (the natural way we learn a language). It can lead to emotional and attitudinal problems explained by the **affective filter hypothesis.**[11]

There are **affective dimensions**[12] which can reduce a person's ability to learn a language. These include low motivation, negative attitudes, poor self-esteem, and anxiety. If one or more of these are active, even if teaching is high quality, the filter is said to rise and reduce the potential for successful learning performance.

The affective filter can be lowered if the language learner's mind is diverted from learning about abstracts of language towards using language to learn meaningful content.

Successful language learning can be achieved through a blend of opportunities for language acquisition and language learning. This is achieved through variant models of **Content and Language Integrated Learning (CLIL).**[13]

8 **The Acquisition-Learning Hypothesis:** that a person can learn language in two ways, through largely subconscious language acquisition, and through largely conscious explicit language learning (see Stephen Krashen The Monitor Model; see Noam Chomsky The Language Acquisition Device).

9 **The Comprehension Hypothesis:** that a person learns language through acquisition when engaging with and understanding content which is meaningful (see Stephen Krashen The Monitor Model; see Noam Chomsky The Language Acquisition Device).

10 **Maximum Exposure Hypothesis:** originally linked to political discussion in North America, it is used to explain something that is intuitively sound but not supported by evidence, namely that that the amount of time-on-task is a determiner for successful or unsuccessful language learning (see Jim Cummins).

11 **Affective Filter Hypothesis:** affective filter is a metaphor for an imaginary barrier that is said to block learning when it is up and enable successful learning when it is down. When a person learns language they may understand the surface meaning of something, but if s/he has negative feelings or emotions resulting from stress, low-self-esteem, anxiety, or disengagement, their capacity to understand is hindered and learning is ultimately unsuccessful (see Stephen Krashen The Monitor Model; see Noam Chomsky The Language Acquisition Device).

12 **Affective Dimensions:** feelings and emotional aspects of learning and being a learner that can trigger the affective filter and reduce the capacity to successfully learn which include self-direction, lack of purpose, anxiety, lack of confidence, low self-esteem, and negative thinking.
belief systems, emotions, and attitudes - all learning has an emotional base (Plato)

13 **Content and Language Integrated Learning (CLIL):** a dual-focused educational approach in which an additional language is used for the learning and teaching of both content and language (see David Marsh)
using language to learn, and learning to use language

CLIL enables learners to reduce negative affective effects resulting from **psychological distance.**[14]

By triggering a simultaneous process of acquisition and learning, it can be possible to move towards enacting a **flow of learning.**[15]

The Flow of Learning is a psychological state in which learners concentrate on a challenging task that is within their **Zone of Proximal Development (ZPD)**[16], the affective filters are open, and the learning experience results in positive levels of personal satisfaction. An outcome can be deep learning.

A person may learn a language over many years as the object of study. This can result in that person being able to show knowledge of the language in tests, but not being able to think in the language to any great extent. In this case any value resulting from the time spent on language study may be in test results, and possibly career prospects, but not in terms of benefit to **mind and brain**.[17]

The possible benefits to mind and brain resulting from being able to think in more than one language is now a focus of research. The two languages form a connected system which is unique for thinking processes. This is one reason for interest in **translanguaging**[18] in languages education.

Benefits are reported even when a learner starts to use an additional language for thinking and learning. These benefits may be physiological, neurological, and psychological. They are significant in understanding the relationship between fluid and crystallized intelligence.

Since 2000 research on language, mind, and brain, has seen exponential growth. During 2000-2020 advances in cognitive neuroscience have enabled researchers to see the physical structure and activities in the brain on an unprecedented scale. This research is heavily focused on people who have acquired and learnt two or more languages. It is rarely on those people who have learnt a language solely as an object of study.

14 **Psychological Distance:** as defined in Construal Level Theory where there is distance between a person and something which may be in terms of time, physical space, interpersonal relations, and the gap between something being actual or hypothetical (see Yaacov Trope and Nira Liberman).
cognitive separation

15 **Flow of Learning:** a highly focused mental state that people experience when they are engaged in an activity with a high level of concentration which can lead to deep learning (see Mihály Csíkszentmihályi).
immersed, energized, involved, and enjoying a process

16 **Zone of Proximal Development (ZPD):** level of potential learning a person can achieve with sufficient scaffolding and support (see Lev Vygotsky).
also known as Zone of Potential Development

17 **Mind and Brain:** whereas the brain is a physical organ, the mind includes what happens within the brain such as mental processes, thought and consciousness. It is difficult to separate these when examining specific research data.

18 **Translanguaging:** The bilingual mind has two languages which form a unitary linguistic system. Translanguaging involves using this greater capacity for thinking and action. In education it involves the systematic use of two languages for learning content. (see Cen Williams; see Ofelia García & Li Wei)

There is an increasingly extensive body of knowledge which reveals that people who use more than one language have enhanced cognitive functioning when compared to monolinguals. In addition, there is a greater potential for such people to develop fluid intelligence and creativity.

The research reveals six significant advantage clusters for people who can think, to a greater or lesser extent, in more than one language.

The implications for arguing that bilingual education, even small-scale, is superior to monolingual education are strong, persuasive, and increasingly supported by science.

3. The Bilingual Advantage for Mind & Brain: what we should know

The Flexible Mind

The flexible mind is about an extension of the capacity to think.

Think of this in terms of the human body. A person who is fit is more able to respond to different physical demands. This means that s/he has some capacity for physical flexibility. In a similar way, a flexible mind is one which can adapt itself to the thinking demands of different situations. A flexible mind is an adaptable mind.

Speaking more than one language is being shown to bring cognitive benefits. These may be associated with increased use of the brain. One potential benefit is mental flexibility which can lead to enhanced creativity.

The extent to which the bilingual mind is adaptable is of great interest across research disciplines. Anecdotally a bilingual is said to be 'able to see the world through different types of lens'. These hypothetical lenses enable the capacity for choice. This capacity is linked to the mind having the potential to be flexible in adapting to different situations in life. Enhanced mental flexibility is key to the development of fluid intelligence.

Being able to look at the same thing – for example, a problem or some other form of challenge – from different points of view is also integral to developing global competences. Access to information, and the need to navigate this through **critical thinking** [19], gives a person ability to look at things from different perspectives.

Cognitive flexibility, such as in being able to effectively engage in **divergent and convergent thinking**[20] (thinking broadly across a range of possible ideas or in a very focused way), is clearly an asset in developing global competences, and for navigating the complexities of life in the Information Age. As global competences are increasingly viewed as a pre-requisite for successful adulthood the bilingual may have advantages not available to the monolingual.

The Problem-solving Mind

Having more than one language is reported as providing enhanced cognitive control. In understanding cognitive control, it is necessary to examine **executive function**.[21]

The bilingual mind operates with more than one language. This means that it needs to rely on neural architecture which differs from

19 **Critical Thinking:** intellectual process enabling a person to objectively analyse and evaluate an issue
reviewing, evaluating, revising

20 **Divergent and Convergent Thinking:** generating new ideas by exploring different potential solutions represents divergent thinking. Convergent thinking involves exploring potential solutions by following a sequence of logical steps and rational thinking (see Joy Paul Guilford).
using imagination, using logic

21 **Executive Function:** cognitive processes that consciously control our thoughts, emotions, and behaviours to achieve goals. These include inhibitory control, attention control, cognitive flexibility amongst others. Higher order executive functions include reasoning and problem-solving which are a part of fluid intelligence (see Michael Posner, Joaquin Fuster, Tim Shallice). A meta-analysis carried out in 2018 found 54.3% research reporting bilingual advantage on cognitive control tasks; 28.3% mixed results; 17.4% evidence against its existence. (see van den Noort, M. et al., 2019).
the brain's CPU – managing functions basic for all cognitive life

the monolingual mind which has only one fundamental linguistic frame of reference. One focus in research is to explore how bilingual 'executive function' provides a cognitive asset, which could enhance the potential for developing fluid intelligence. A range of reports argue that bilinguals have executive function capacity which is superior in various ways to that of monolinguals.

Executive function is fundamental to all cognitive life. It includes attention, flexible thinking, self-control, and management of working memory. These help an individual to plan, monitor, and successfully achieve goals in life.

Research on executive function processing indicates a bilingual advantage in relation to aspects of problem-solving, including abstract thinking skills, creative hypothesis formulation, higher concept formation skills, and overall higher mental flexibility. Such advantage may be linked to the management of two or more active language systems, and the experience of that management over time.

Being able to interpret information and solve problems involves not only deciding what to give attention to, but also what not to give attention to. This is reportedly a feature of the enhanced cognitive ability which bilinguals have and is linked to the development of global competence. Being able to ignore distracting and irrelevant stimuli is a key skill when needing to process a large amount of information at a given time. Separating what is important information from what is not, distinguishing fact from fiction, is a problem-solving skill basic to systems thinking.

Attention to task is important for problem-solving and learning in general. It is said that attention drives memory and learning. The bilingual mind is already involved with giving attention to separating the language processing frameworks resulting from knowing more than one language. This is especially the case in terms of handling ambiguity and different representations created by words and avoiding undue distraction.

Some studies have looked at problem-solving with respect to bilingual and monolingual behaviour when people are involved with multimedia gaming. This links to development of types of competence for navigating information and communications technology. It is one feature of **digital literacy.**[22] These studies reveal that bilinguals tend to have an advantage in problem-solving which is cognitively demanding, and also when processing demands are high.

Bilinguals may be better at handling highly complex tasks and demanding thinking processes through the ability to engage in **conceptual expansion.**[23] Conceptual expansion is closely aligned to fluid intelligence and higher order problem-solving capacity. Put simply, it is reported that knowing more than one language may help the brain sharpen its ability to focus.

Interest in cognitive processing demands has led to suggestions that the bilingual mind may be better at multitasking than the monolingual mind. This is partly attributed to research on attention and inhibitory control. Multitasking can be considered as the simultaneous handling of more than one task. It is linked to executive function and may be a form of multicompetence.

22 **Digital Literacy:** ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills. American Library Association (ALA).
Digital as an emergent language

23 **Conceptual Expansion:** expansion of a person's conceptual system which can lead to enhanced creativity and the formulation of new ideas.
Thinking outside the box

The Metalinguistic Mind

Metalinguistics includes development of **morphological awareness**.[24] This is the ability to reflect on and build awareness of language. It enables a person to understand how language is used to achieve specific goals in life, and how to achieve deeper understanding of language function in different situations. Language awareness also gives the potential for enriched information processing which, in turn, can contribute to the development of global competences.

By having more than one language a bilingual may be able to develop metalinguistic skills in ways in which a monolingual cannot. The bilingual has the capacity to develop critical awareness of language and communication through more than one system, whereas the monolingual only has one.

Understanding that words can have more than one meaning; identifying ambiguity in communication; translating words and interpreting concepts; and seeing the sub-text underlying how language is used to convey meaning for both positive and possibly nefarious purposes is a type of understanding which can be called pragmatic skill.

Pragmatics[25] involves the communication skills we use with other people such as non-verbal language, appropriacy of style, politeness, choice of vocabulary, tone, and intonation. Pragmatic skills involve understanding of how to use language to achieve goals in communication and is a key component of metalinguistic awareness.

The metalinguistic mind also enables a person to have specific types of ability in handling interpersonal dynamics in using language for communication. Essentially, it enables the person to 'go beyond words' in interpreting communication. It is closely linked to improved reading skills through phonemic awareness (understanding sounds and symbols), and a heightened potential for empathy towards others in interpersonal communication. In this context it links to **critical thinking**.[26] By being able to draw on two language systems to understand and articulate thought and meaning, the bilingual may find it easier to engage with **cognitive flexibility**[27] than a monolingual.

24 **Morphological Awareness:** recognition and understanding of how words are made up of useful units which enables deeper lexical skills within and across languages and is a significant contributor to helping people read and spell.
the building blocks of language

25 **Pragmatics:** the study of meaning in context leading to understanding of the contexts in which people communicate to help interpret the intended meaning of how they use language in certain ways (see J. L. Austin; Paul Grice; Penelope Brown and Stephen Levinson).
decoding what people really mean when they communicate

26 **Critical Thinking:** making judgements by analysing what is factual objectively and rationally (see Socratic questioning).
Challenging assumptions, rationally and independently drawing conclusions

27 **Cognitive Flexibility:** higher order cognition processes enabling a person to think about something from different perspectives, mentally adapt to context, and restructure knowledge (see Jean Piaget).
looking at life through different lenses

Research argues that the interaction of two or more languages in the mind has the potential to enrich both linguistic systems. Appropriate development of bilingualism leads to an experience which is additive, not subtractive. Additive means that even if a bilingual, for example a younger person, may unintentionally mix words and phrases in communication, cognitively the L1 and L2 provide an extra capacity which has been termed **multicompetence.**[28] This results in a greater capacity for thinking and communication because there are two possibly very different language systems being activated at the same time. The fusion of both languages forms a unitary linguistic competence, a single language system to think and achieve goals in life. One outcome may include having the potential to fuel the emergence of new ideas through conceptual expansion.

The Learning Mind

Modern cognitive theories generally assume that people learn through interaction with their environment. This is a process where the person uses their previous knowledge (crystallized intelligence) to make sense of the environment around them by engaging with **constructive processes.**[29]

This involves new knowledge being constructed and learnt, and then integrated with previous knowledge. The outcomes of such knowledge constructions are always more than the sum of what is initially perceived in the environment; they are new concepts and forms of understanding based on a fusion of what is already known and what has been recently learnt. So, learning involves not just adding information to information already stored, but also the construction of new knowledge.

Research indicates the possibility of a bilingual advantage through enhanced memory function. The ability to retain, organise, store, and retrieve information is obviously a vital human competence. Any possibility for enhanced memory function has considerable significance in relation to learning and education in general.

There may be specific neuro-circuitry and multisensory brain systems (changes in brain organisation, inter-hemispheric transfer, and functional plasticity) which enable change to be found amongst bilinguals. What is clear is that bilingualism and bilingual learning can have a significant impact on brain structures.

One example relates to what is termed **cross-language interactivity.**[30] This is specific to bilinguals and not available to monolinguals. It involves **semantic and episodic memory.**[31]

28 **Multicompetence:** the different languages people know form a connected system, a unique resource for thinking and action, rather than each language being a separate system (see Vivian Cook).
1+ 1= 3

29 **Constructivism:** knowledge constructed through interaction with other people (see Jerome Bruner, John Dewey, Jean Piaget, Lev Vygotsky).
learning by construction, not by instruction

30 **Cross-language Interactivity:** potential for bilingual advantage when two languages are co-activated during language processing and there is interaction between two linguistic systems (see François Grosjean).
the whole is greater than the sum of its parts

31 **Semantic and Episodic Memory:** semantic = remembering general facts, factual and conceptual knowledge of the world; episodic = memories of events that the person has experienced in life (see Endel Tulving).
November 1989: the time the Berlin wall came down, and the time I fell in love with Greta

Whereas episodic memory involves personal memory of events and experiences, semantic memory involves recalling general facts.

Working memory[32] enables people to temporarily retain information so that the brain can 'think'. Information that is retained becomes **cognitive load.**[33] This is the amount of memory resources used at a specific time. A bilingual advantage in maximizing the effectiveness of cognitive load is reported in research, including superior performance of depth and syntactic complexity in hypothesis formation.

One widely held but now theoretically unsound definition of a bilingual is of a person who speaks two languages fluently. Such a definition leads to the assumption that any advantage from knowing a second language is only realised when a high degree of **fluency**[34] is achieved.

But it is now increasingly reported that change in the brain can be found after relatively little exposure to a second language and that impact on the brain's electrical activity may occur even with limited exposure to certain types of language learning experience. This is particularly relevant with respect to how language teaching and learning is designed and implemented, and how language learning is valued within educational curricula.
The affective dimensions of learning may be one reason why there is a reaction to limited exposure, especially if this results from an experience of language acquisition, and not only language learning. The role of emotion is a key determiner in language learning. Insights relating to the affective filter involving emotional factors such as motivation, attitudes, self-esteem, and anxiety can enhance, hinder, or block successful language learning.

The Interpersonal Mind

A bilingual advantage is reported in enhancement of interpersonal communication awareness and skills. For example, an ability to see that people have differing, or even false beliefs, is said to develop earlier in bilinguals than in monolinguals.

The impact of bilingualism on interpersonal communication is reported in terms of understanding and responding to the communicative needs of others; contextual sensitivity; interactional competence in communication; and enhanced skills in differentiating languages in contextually sensitive ways. This suggests that bilingualism

32 **Working Memory:** a cognitive system a person has enabling them to keep information temporarily accessible while dealing with thinking processes, distractions, or attention shifts (see Ellen Bialystock). *the RAM of the brain*

33 **Cognitive Load:** the amount of working memory resources used at a given time (see John Sweller). *the used capacity of the brain's information processor*

34 **Fluency:** Language fluency is an elusive term which can be understood in different ways. There is opinion that a person is fluent in a language when they have a B2 (CEFR). But being competent in using a language is more complex than simply setting a language test standard. For example, a person may be highly able (fluent) in using an additional language in some situations, but quite unable to use it successfully in others. A person may be able to use language to a high level in one domain (a social or other context of interaction) such as in air transport or a religious setting, but to a low level in another domain such as in a hospital, or an interview on contemporary affairs. Equally is the case that a person may be fluent in speech, but not in writing.
not all or nothing, but more or less

tends towards strengthening of multi-skills in interpersonal interaction.

Interpersonal communication involves communicating with one or more people. In so doing it links directly to **intercultural communication competences.**[35] Any bilingual advantage could be related to enhanced **inhibitory control.**[36] This is a cognitive process where a person can think beyond first impression impulses with heightened mental flexibility when choosing an appropriate response in human communication.

In intercultural contexts this can lead to enhanced communicative sensitivity and having a greater perceptive understanding of people. This includes understanding the world from different perspectives, nurturing empathy, and being aware of the communication signalling processes of other people.

The Ageing Mind

Research focuses on the implications of a bilingual advantage in relation to age-related neurodegeneration. It is argued that changes in the executive function and working memory resulting from knowledge of more than one language may slow down the rate of decline of certain cognitive processes as a person becomes older.

Put simply, if the brain has more than one linguistic processing system and is affected by organic or functional deterioration through normal ageing, or even possibly forms of dementia, the rate of deterioration may be slowed down. Thus, rates of loss of cognitive function may be reduced by the greater capacity afforded by the different languages.

The implications of any offset of age-related diminishment of cognitive function and processes could be considerable. It is argued that bilinguals have a **cognitive reserve**[37] which helps protect against degenerative aspects of ageing. Cognitive reserve is considered to provide a general protective function, possibly due to enhanced neural plasticity, compensatory use of alternative brain regions, or enriched brain vasculature. In these respects, bilingualism is seen as enabling the brain to reduce the negative impact of accumulated pathologies. If this is the case then the consequences may be considerable for not only individuals and families, but also health care systems, and ultimately societies.

35 **Intercultural Communication Competences:** understanding and responding to differences in assumptions, values, perspectives, and strategies in human communication.
situational adaptability

36 **Inhibitory Control:** conscious or unconscious constraint of potentially inappropriate and suboptimal actions, especially impulses or desires.
an executive function also called response inhibition

37 **Cognitive Reserve:** a person's capacity to help the brain cope with the negative impact of brain dysfunction or damage.
the warehouse within the mind and brain

4. Education in the 21st Century: what we now know

In some educational systems there is disjuncture between what a child needs to learn for future life and what is provided through schooling.

To align education with contemporary realities a shift in curricular structures (what is to be learnt) and pedagogies (how teaching and learning happens) is required. This would enable intended learning outcomes to include the development of crystallized intelligence (encyclopaedic knowledge) and fluid intelligence (adaptive knowledge and skills).

Simultaneously developing crystallized and fluid intelligence helps enable a person to develop systems thinking. Systems thinking involves being skilled in filtering through knowledge to see patterns and the interrelatedness of phenomena.

In education this requires moving from valuing surface learning (e.g. short-term memorization of knowledge for tests) to deep learning (e.g. long-term memorization of higher order adaptive knowledge and skills).

A major shift in formal and operational curricula (what should be taught, for what purpose, and how) is required in three interrelated ways.

First, the school curriculum should be internationalized so that local and global knowledge intended learning outcomes are combined. Second, intended learning outcomes should include the development of global competences. Third, high-impact teaching methods should be aligned to realize these intended learning outcomes.

In the case of language teaching there is an ever-widening chasm between good and poor practice. There are many reasons for this including the undue influence of certain commercial interests, and professional inertia. Poor teaching practice may also be due to misplaced conventional wisdom (we teach the way we learnt at school), and language educators unaware of relevant and sometimes profound research outcomes.

What the evidence reveals is that the bilingual mind has cognitive and other strengths which are particularly appropriate for developing 21st century skills. Evidence of the impact of bilingualism on societies is reported elsewhere as added value in relation to economics, social cohesion, security, and inclusion.

Bilingual learning can have a profound effect on brain structures, and especially the corpus callosum. There may be specific neuro-circuitry and multisensory brain processes (changes in brain organisation, inter-hemispheric transfer, and functional plasticity) which enable certain types of change to be found in bilingual but not in monolingual minds.

Changes in the brain's electrical activity may occur much earlier than previously thought even with limited exposure to language learning. The neuronal structures are likely to influence change if the language learning environment is based on good pedagogy. This suggests that even low levels of ability in a second language can lead to, for example, metalinguistic advantages during the early stages of second language acquisition.

Successful language learning requires a blend of language learning and language acquisition through high-impact dialogic teaching and learning activities which are meaningful, relevant, and engaging. This blend can be seen in the application of Content and Language Integrated Learning (CLIL). CLIL involves use of bilingual methodologies which are essential for any form of successful bilingual education programme.

In the present day there are profound arguments for providing education in more than one language. These are not only anchored in ideas generated by philosophers over at least two thousand years, but now driven by advances in science, especially on mind and brain. As monolingual education appears to

be conspicuously outdated, lack of attention to cultivating global competences and systems thinking through the reported bilingual advantage is increasingly unjustifiable.

There are two educational scenarios prevalent in the world today. Thanks to the insights of forward-thinking educators and researchers, complemented now by evidence from the neurosciences, we have the know-how, and ultimately the choice.

We can stay with the status quo which is frequently out-dated, or have decision-making guided by evidence and insight, and make a difference to the lives of the young people in our schools, colleges, and universities.

Outdated Education Scenario	Leading-edge Education Scenario
Educational systems operate through a **monolingual** paradigm	Educational systems operate through a **multilingual** paradigm
Limited international focus in curricula	**Embedded international focus** in curricula
Subject teaching **separated and fragmented**	Subject teaching **separated and partly integrated**
Language teaching based on **grammar-based instruction**	Language teaching based on **integration with relevant content**
Learning goals **not aligned** to global competences	Learning goals **aligned** to global competences
Learning activities **not aligned** to fluid intelligence	Learning activities **aligned** to fluid intelligence
School ethos **not enabling** systems thinking, creativity and innovation	School ethos **enabling** systems thinking, creativity and innovation
Dominant use of **standardized tests which measure crystallized intelligence**	**Tests** measure **both crystallized and fluid intelligence**
Schools encourage students to **value short-term surface learning** (learning for the test) and not long-term deep learning (building complex understand and meaning)	Schools encourage students to **value long-term deep learning** (building complex understand and meaning) and not only short-term surface learning (learning for the test)

REFERENCES

Abutalebi, J. (2008) Neural aspects of second language representation and language control. Acta Psychologica, 128, 466–478.

Abutalebi, J. Costa, A. (2008) Editorial, Acquisition, Processing and Loss of L2: Functional, cognitive and neural perspectives. Journal of Neurolinguistics 21, 473–476

Abutalebi, J., DellaRosa P., Green D, (2012) Bilingualism tunes the anterior cingulate cortex for conflict monitoring, Cerebral Cortex, 22, 9, 2076–2086.

Abutalebi, J., Della Rosa, P., Gonzaga, A., Keim, R., Costa, A., Perani, D. (2013) The role of the left putamen in multilingual language production. Brain and Language, 125, 307–315.

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

Ansaldo, A., Marcotte, K., Fonseca, R., Scherer, L. (2008), Neuroimaging of the bilingual brain: evidence and research methodology. PSICO, Porto Alegre, PUCRS. 39, 2, 131-138.

Antoniou M. (2019) The Advantages of Bilingualism Debate. Annual Review of Linguistics 5, 1, 395-415.

Badzakova-Trajkov, G., Kirk, I., Waldie, K. (2008) Dual-task performance in late proficient bilinguals. Laterality: Asymmetries of Body, Brain, and Cognition, 13, 201–216.

Baetens Beardsmore, H. (2008) Multilingualism, Cognition and Creativity. International CLIL Research Journal, 1, 1, 4-19.

Bak T. (2016) The impact of bilingualism on cognitive aging and dementia: Finding a path through a forest of confounding variables. Linguistic Approaches to Bilingualism 6, 205–226.

Bamford, K. and Mizokawa, D. (1991) Additive-bilingual (immersion) education: Cognitive and language development. Language Learning 41, 3, 413-429

Bartolotti, J., and Marian, V. (2012) Language learning and control in monolinguals and bilinguals. Cognitive Science, 36, 1129–1147.

Becky W., Bin Y., O'Brien B., (2016) Neurolinguistics: Structure, Function, and Connectivity in the Bilingual Brain, BioMed Research International, ID 7069274.

Bekhtereva, N., Dan'ko, S., Starchenko, M., Pakhomov, S. & S. Medvedev (2001) Study of the brain organization of creativity: III. Brain activation assessed by the local cerebral blood flow and EEG. Human Physiology, 27, 4 390-397.

Belz, J. (2002) The myth of the deficient communicator. Language Teaching Research 6, 59–82

Bialystok, E. (1986) Factors in the growth of linguistic awareness, Child Development 57, 498-510

Bialystok, E. (2006) Effect of bilingualism and computer video game experience on the Simon task. Canadian Journal of Experimental Psychology, 60, 68–79

Bialystok, E. (2007) Cognitive Effects of Bilingualism: How Linguistic Experience Leads to Cognitive Change. International Journal of Bilingual Education and Bilingualism, 10, 3, 210

Bialystok E. (2016) How hazy views become full pictures, Language, Cognition and Neuroscience 31, 3, 328-330.

Bialystok, E, and Hakuta, K. (1994) In Other Words: The Science and Psychology of Second-Language Acquisition. New York: Basic Books

Bialystok E., Craik F., Luk G. (2012) Bilingualism: consequences for mind and brain. Trends in Cognitive Science, 16, 240–250.

Bialystok, E., Craik, F., Grady, C., Chau, W., Ishii, R., Gunji, A. & Pantev, C. (2005) Effect of bilingualism on cognitive control in the Simon task: Evidence from MEG. NeuroImage, 24, 1, 40–49

Bialystok,E, Craik, F., Freedman, M. (2007) Bilingualism as a protection against the onset of symptoms of dementia. Neuropsychologia, 45, 459-464

Bialystok, E. and Shapero, D. (2005) Ambiguous benefits: the effect of bilingualism on reversing ambiguous figures. Developmental Science, 8, 6, 595-604

Bialystok,E., Shenfield, T., Codd, J. (2000), Language, scripts, and the environment: factors in developing concepts of print. Developmental Psychology 36, 66-76

Bialystok E. and Viswanathan M. (2009) Components of executive control with advantages for bilingual children in two cultures. Cognition, 112, 494–500.

Brookmeyer R., Gray S., Kawas C., (1998) Projections of Alzheimer's disease in the United States and public health impact of delaying disease onset. American Journal of Public Health 88:1337-1342

Brown, A., and Gullberg, M. (2010) Changes in encoding of PATH of motion in a first language during acquisition of a second language. Cognitive Linguistics, 21, 263–286.

Brysbaert M. and Duyck, W. (2010) Is it time to leave behind the revised hierarchical model of bilingual language processing after fifteen years of service?, Bilingualism: Language and Cognition, 13, 3, 359–371.

Brito, N. (2020) Dual Language Exposure and Early Learning, The Cambridge Handbook of Infant Development, 661-684.

Bruin, A. and Della Sala, S. (2016) The importance of language use when studying the neuroanatomical basis of bilingualism, Language, Cognition and Neuroscience, 31:3, 335-339

Bull R. and Lee K. (2014) Executive functioning and mathematics achievement, Child Development Perspectives, 8, 1, 36–41.

Burgaleta M., Sanjuán A., Ventura-Campos N., Sebastián-Gallés N., Ávila C. (2016) Bilingualism at the core of the brain. Structural differences between bilinguals and monolinguals revealed by subcortical shape analysis. Neuroimage 125, 437–445.

Calabria, M., Hernández, M., Branzi, F., Costa, A. (2012) Qualitative differences between bilingual language control and executive control: Evidence from task-switching. Frontiers in Psychology, 2, 399.

Calvo, N., Ibáñez, A., García, A. (2016) The Impact of Bilingualism on Working Memory: A Null Effect on the Whole May Not Be So on the Parts, Frontiers in Psychology, 7: 265

Carlson, S. and Meltzoff, A. (2008) Bilingual experience and executive functioning in young children. Developmental Science, 11, 2, 282-298

CERI (2007) Understanding the Brain: The Birth of a Learning Science. OECD: Paris

Cespón J. and Carreiras M. (2020) Is there electrophysiological evidence for a bilingual advantage in neural processes related to executive functions? Neuroscience & Biobehavioral Reviews, 118, 315-330.

Colzato, L., Bajo, M., van den Wildenberg, W., Paolieri, D., Nieuwenhuis, S., La Heij, W.,and Hommel,B. (2008) How does bilingualism improve executive control? A comparison of active and reactive inhibition mechanisms. Journal of Experimental Psychology: Learning, Memory and Cognition 34, 2, 302-312

Clarkson, P. (2007) Australian Vietnamese students learning mathematics: High ability bilinguals and their use of their languages. Educational Studies in Mathematics, 64, 195215

Claussenius-Kalman H., Vaughn K., Archila-Suerte P., Hernandez, A. (2020) Age of acquisition impacts the brain differently depending on neuroanatomical metric. Human Brain Mapping 41,2, 484-502.

Cockcroft K., Wigdorowitz M., Liversage L. (2019) A multilingual advantage in the components of working memory. Bilingualism: Language and Cognition 22,1, 15-29.

Coggins, P., Kennedy, T., Armstrong, T. (2004), Bilingual corpus callosum variability. Brain and Language 89, 69-75

Cook, V. (1992) Evidence for multi-competence. Language Learning 42, 4, 557–91

Costa A., Hernández M., Costa-Faidella J., Sebastián-Gallés N. (2009) On the bilingual advantage in conflict processing: now you see it, now you don't. Cognition, 113, 135–149.

Costa A., Hernández M, Sebastián-Gallés N. (2008) Bilingualism aids conflict resolution: evidence from the ANT task. Cognition, 106, 59–86.

Costa A. and Sebastián-Gallés N. (2014) How does the bilingual experience sculpt the brain? Nature Reviews Neuroscience, 15, 336–345.

Cox J. and Zlupko G. (2019) Individual differences in language experience and bilingual autobiographical memory. International Journal of Bilingualism 23, 5, 1180-1194.

Cummine J., and Boliek, C. (2013) Understanding white matter integrity stability for bilinguals on language status and reading performance, Brain Structure and Function, 218,2, 595–601.

Cummins, J. (1977) Cognitive factors associated with the attainment of intermediate levels of bilingual skills. Modern Language Journal, 61, 3-12

Czapka, S., Wotschack, C., Klassart, A. and Festman, J. (2020) A path to the bilingual advantage: Pairwise matching of individuals, Bilingualism, Language and Cognition, 23, 2, 344-354.

Danylkiv A. and Krafnick A. (2020) A Meta-Analysis of Gray Matter Differences Between Bilinguals and Monolinguals. Frontiers in Human Neuroscience 14.

Das T., Padakannaya, P., Pugh K., Singh N. (2011) Neuroimaging reveals dual routes to reading in simultaneous proficient readers of two orthographies," NeuroImage, 54, 2,1476–1487.

DeLuca V., Rothman J., Bialystok E., Pliatsikas C. (2019) Redefining bilingualism as a spectrum

of experiences that differentially affects brain structure and function. Proceedings of the National Academy of Sciences 116,15, 7565-7574.
DeLuca V., Rothman J, Pliatsikas C (2018) Linguistic immersion and structural effects on the bilingual brain: A longitudinal study. Bilingualism Language and Cognition 1, 1–16.
Dietrich, A. (2007) Who's afraid of a cognitive neuroscience of creativity? Methods 42, Elsevier
Doidge, N. 2007. The Brain that Changes Itself. Penguin: London
Duñabeitia. J. (2014) The inhibitory control in bilingual children revisited, Experimental Psychology, 61, 234-251.
Emmorey K., Luk G., Pyers J., Bialystok E. (2008) The source of enhanced cognitive control in bilinguals: evidence from bimodal bilinguals. Psychological Science,19, 1201–1206.
Engel de Abreu P., Cruz-Santos A., Tourinho C., Martin R., Bialystok E. (2012) Bilingualism enriches the poor: enhanced cognitive control in low-income minority children. Psychological Science, 23, 1364–1371.
Eviatar, Z and Ibrahim, R. (2000) Bilingual is as bilingual does: Metalinguistic abilities of Arabic-speaking children. Applied Psycholinguistics 21, 451-471
Flynn, S., Foley, C. and Vinnitskaya I. n(2004) The Cumulative-Enhancement model for language acquisition: comparing adults' and childrens' patterns of development in first, second and third language acquisition of relative clauses. The International Journal of Multilingualism 1, 1, 13-16.
Fratiglioni, L., Paillard-Borg, S., & Winblad, B. (2004). An active and socially integrated lifestyle in late life might protect against dementia. Lancet Neurology, 3, 343-353
Fricke M., Zirnstein M., Navarro-Torres C., Kroll J. (2019) Bilingualism reveals fundamental variation in language processing. Bilingualism: Language and Cognition 22,1, 200-207.
Friederici, A. (2011) The brain basis of language processing: from structure to function," Physiological Reviews, 91, 4, 1357–1392.
Friederici A. and Gierhan S., (2013) Language network, Current Opinion in Neurobiology, 23, 2, 250–254.
Friesen D. and Bialystok E. (2013) Control and representation in bilingualism: implications for pedagogy,"in Innovative Research and Practices in Second Language Acquisition and Bilingualism, 38, 223–240, Amsterdam: John Benjamins.
Garbin, G., Sanjuan, A., Forn, C., Bustamante, J., Rodriguez-Pujadas, A., Belloch, V., & Avila, C. (2010) Bridging language and attention: Brain basis of the impact of bilingualism on cognitive control. NeuroImage, 53, 4, 1272–1278
Gallo F., Novitskiy N., Myachykov A., Shtyrov Y. (2020) Individual differences in bilingual experience modulate executive control network and performance: behavioral and structural neuroimaging evidence. Bilingualism: Language and Cognition, 1-12.
Garbin, G., Sanjuan A., Forn, C., Bustamante J., Rodriguez-Pujadas A., Belloch, V., Hernandez M., Costa A., Ávila A. (2010) Bridging language and attention: Brain basis of the impact of bilingualism on cognitive control, NeuroImage, 53, 4, 1272-1278.
García A. (2019) The Neurocognition of Translation and Interpreting. Benjamins Translation Library.
García-Pentón, L., Fernández García F., Costello B., Andoni Duñabeitia J., Carreiras, M. (2016) "Hazy" or "jumbled"? Putting together the pieces of the bilingual puzzle. Language, Cognition and Neuroscience, 31,3, 353-360.
Gasser,M. (1990) Connectionism and universals of second language acquisition, Studies in Second Language Acquisition, 12, 2, 179–1990.
Giussani, C., Roux, F. E., Lubrano, V., Gaini, S. M. & Bello, L. (2007) Review of language organisation in bilingual patients: what can we learn from direct brain mapping? Acta Neurochirurgica, 149, 1109-1116
Goetz, P. (2003) The effects of bilingualism on theory of mind development. Bilingualism: Language and Cognition, 6, 1 – (1-15)
Gold B., Johnson N., Powell D. (2013) Lifelong bilingualism contributes to cognitive reserve against white matter integrity declines in aging. Neuropsychologia, 51, 2841–2846.
Golestani, N. (2014) Brain structural correlates of individual differences at low-to-high-levels of the language processing hierarchy: are view of new approaches to imaging research, The International Journal of Bilingualism, 18, 1,6–34.
Grady C., Luk G., Craik F., and Bialystok, E. (2015) Brain Network Activity in Monolingual and Bilingual Older Adults, Neuropsychologia, 66, 170–181
Grey S., Sanz C., Morgan-Short K., Ullman M. (2017) Bilingual and monolingual adults learning an additional language: ERPs reveal differences in syntactic processing. Bilingualism: Language and Cognition, 21, 5, 970-994
Green D. and Abutalebi J. (2013) Language control

in bilinguals: the adaptive control hypothesis. Journal of Cognitive Psychology, 25, 515–530.
Green D. and Abutalebi, J. (2016) Language control and the neuroanatomy of bilingualism: in praise of variety, Language, Cognition and Neuroscience, 31:3, 340-344.
Grogan A., ParkerJones O.,Ali N.,Crinion J.,Orabona S.,Mechias M, Ramsden S., Green D., Price C. (2012) Structural correlates for lexical efficiency and number of languages in non-native speakers of English. Neuropsychologia, 50, 1347–1352.
Guilford, J. & Hoepfher, R. (1971) The Analysis of Intelligence. New York: McGraw Hill
Hakuta, K. (1990) Language and cognition in bilingual children, in A. Padilla, C. Valdez & H. Fairchild (eds.). Bilingual Education: Issues and Strategies (47-59). Newbury Park, California: Sage Publications
Haritos,C. (2005) The language ecology of bilingual memory. Academic Exchange Quarterly 9, 3, 77-82
Hernandez A., (2009) Language switching in the bilingual brain: what's next?, Brain & Language, 109, 2-3, 133–140.
Hernandez, A. E., Dapretto, M., Mazziotta, J., & Bookheimer, S. (2001) Language switching and language representation in Spanish-English bilinguals: An MRI study. NeuroImage, 14, 510-520
Hernández, M., Martin, C., Barceló, F., Costa, A. (2013) Where is the bilingual advantage in task-switching?, Journal of Memory and Language, 69, 3, 257-276
Hervais-Adelman A., Moser-Mercer B., Golestani, N. (2011) Executive control of language in the bilingual brain: integrating the evidence from neuroimaging to neuropsychology, Frontiers in Psychology,2, ID 234,2011.
Hilchey, M. and Klein, R., (2011) Are there bilingual advantages on non-linguistic interference tasks? Implications for the plasticity of executive control processes, Psychonomic Bulletin & Review, 18, 625-658.
Hilchey M., Klein, R., Saint-Aubin J. (2015) Does bilingual exercise enhance cognitive fitness in traditional non-linguistic executive processing tasks?, in The Cambridge Handbook of Bilingual Processing, J. Schwieter, Ed., Cambridge: Cambridge University Press.
Hosoda C., Tanaka K., Nariai T., Honda M., Hanakawa T. (2013) Dynamic neural network reorganization associated with second language vocabulary acquisition: A multimodal imaging study. Journal of Neuroscience 33, 13663–13672.
Jamal N., Piche A., Napoliello E., Perfetti C., Eden G. (2012) Neural basis of single-word reading in Spanish-English bilinguals. Human Brain Mapping, 33, 235–245.
Jasinska,K. and Petitto, L. (2013) How age of bilingual exposure can change the neural systems for language in the developing brain: A functional near infrared spectroscopy investigation of syntactic processing in monolingual and bilingual children. Developmental Cognitive Neuroscience, 6, 87-101.
Jessner, U. (1999) Metalinguistic awareness in multilingual speakers: Cognitive aspects of third language learning. Language Awareness 8, 3 & 4, 201-209.
Jessner, U. A. (2008) DST Model of Multilingualism and the Role of Metalinguistic Awareness. The Modern Language Journal 92, ii.
Kharkhurin, A. V. (2007) The role of cross-linguistic and cross-cultural experiences in bilinguals' divergent thinking, in I. Kecskes and L. Albertazzi (eds). Cognitive Aspects of Bilingualism, 175-210, Springer, Dordrecht
Kharkhurin, A. (2008) The effect of linguistic proficiency, age of second language acquisition, and length of exposure to a new cultural environment on bilinguals' divergent thinking. Bilingualism: Language and Cognition 11,2,225-243, Cambridge University Press
Klaus J., and Schriefers H. (2019). Bilingual Word Production. The Handbook of the Neuroscience of Multilingualism, 214-229.
Klein R. (2016) What cognitive processes are likely to be exercised by bilingualism and does this exercise lead to extra-linguistic cognitive benefits? Linguist Approaches to Bilingualism 5, 549–564
Kormi-Nouri, R., Shojaei, R.-S., Moniri, S., Gholami, A.-R., Moradi, A.-R., AkbariZardkhaneh, S. & Nilsson, L.-G. (2008) The effect of childhood bilingualism on episodic and semantic memory tasks. Scandinavian Journal of Psychology, 49, 93–109
Kroll J., Bobb S., Misra M, Guo T. (2008) Language selection in bilingual speech: evidence for inhibitory processes. Acta Psychologica, 128, 416–430.
Kroll, J. and Bialystok, E. (2013) Understanding the consequences of bilingualism for language processing and cognition, Journal of Cognitive Psychology, 25,5, 497-514.
Kroll, J. and Chiarello, C. (2016) Language experience and the brain: variability, neuroplasticity,

and bilingualism, Language, Cognition and Neuroscience, 31,3, 345-348.
Kroll J., Dussias P., Bice K., Perrotti, L. (2015) Bilingualism, Mind and Brain, Annual Review of Linguistics 1,1, 377-394
Kroll J., Dussias P., Bogulski C., Valdes-Kroff J. (2012) Juggling two languages in one mind. What bilinguals tell us about language processing and its consequences for cognition. Psychology of Learning and Motivation, Ross B. (ed.) San Diego: Academic, San Diego), 229–262.
Lazaruk, W. (2007) Linguistic, Academic and Cognitive Benefits of French Immersion. Canadian Modern Language Review 63 (5) 605-628. Toronto: University of Toronto
Laine, M. and Lehtonen, M. (2018) Cognitive consequences of bilingualism: where to go from here?, Language, Cognition and Neuroscience 33,9, 1205-1212.
Lotus Lin J-F., Imada T., Kuhl P. (2019) Neuroplasticity, bilingualism, and mental mathematics: A behavior-MEG study. Brain and Cognition 134, 122-134.
Luk, G. and Pliatsikas, C. (2016) Converging diversity to unity: commentary on The neuroanatomy of bilingualism. Language, Cognition and Neuroscience, 31, 3, 349-352.
Luk G., Bialystok E., Craik F., Grady C. (2011) Lifelong bilingualism maintains white matter integrity in older adults. Journal of Neuroscience, 31, 16808–16813.
Luk G.,Green D.,Abutalebi J.,Grady C. (2012) Cognitive control for language switching in bilinguals: a quantitative meta-analysis of functional neuroimaging studies. Language and Cognitive Processes, 27, 1479–1488.
Marie, D. and Golestani, N. (2017) Brain structural imaging of receptive speech and beyond: a review of current methods, Language, Cognition and Neuroscience 32,7, 870-890.
Martin-Rhee M. and Bialystok E. (2008) The development of two types of inhibitory control in monolingual and bilingual children. Bilingualism: Language and Cognition, 11, 81–93.
Mechelli A., Crinion J., Noppeneyetal N. (2004) Neurolinguistics: structural plasticity in the bilingual brain, Nature, 431, 757.
Morales, J., Calvo, A., Bialystok, E.(2012).Working memory development in monolingual and bilingual children, Journal of Experimental Child Psychology, 114, 187–202
Miyake A. and Friedman, N. (2012) The nature and organization of individual differences in executive functions: four general conclusions, Current Directions in Psychological Science, 21, 1, 8–14.
Mårtensson J., Eriksson J., Bodammer N. , Lindgren M., Johansson M., Nyberg L., Lövdén, M. (2012) Growth of language-related brain areas after foreign language learning. Neuroimage, 63, 240–244.
(van den) Noort, M.; Struys, E.; Bosch, P.; Jaswetz, L.; Perriard, B.; Yeo, S.; Barisch, P.; Vermeire, K.; Lee, S.-H.; Lim, S. (2019) Does the Bilingual Advantage in Cognitive Control Exist and If So, What Are Its Modulating Factors? A Systematic Review, Behavioural Science, 9,3,27.
Olguin A., Cekic M., Bekinschtein T., Katsos, N., Bozic, M. (2019) Bilingualism and language similarity modify the neural mechanisms of selective attention. Scientific Reports 9,1.
Olulade,O., Jamal, N., Koo, D., Perfetti, C., LaSasso, C., Eden, G. (2016) Neuroanatomical Evidence in Support of the Bilingual Advantage Theory, Cerebral Cortex, 26, 7, 3196–3204.
Osterhout, L., Poliakova, A., Inoue,K., McLaughlin, J., Valentine, G., Pitkanen, I., FrenckMestre, C., and Hirschensohn, J.(2008) Second-language learning and changes in the brain. Journal of Neurolinguistics 21,509–521
Paap, K. (2015) The neuroanatomy of bilingualism: will winds of change lift the fog?", Language, Cognition and Neuroscience 31, 3, 331-334.
Papp, K and Greenberg, Z. (2013) There is no coherent evidence for a bilingual advantage in executive processing, Cognitive Psychology, 66, 2, 232-258.
Paap, K. Myuz, H., Anders R., Bockelman M., Mikulinsky R. Saw O. (2017) No compelling evidence for a bilingual advantage in switching or that frequent language switching reduces switch cost, Journal of Cognitive Psychology 29,2, 89-112.
Peal, E and Lambert, W. (1962) The relation of bilingualism to intelligence. Psychological Monographs 76, 27, 1-23
Perani D. and Abutalebi, J. (2005) Neural basis of first and second language processing, Current Opinion in Neurobiology, 15, 2, 202–206.
Perani D.,Paulesu E.,Galles N.,Dupoux E.,Dehaene S.,Bettinardi V., Cappa S., Fazio F., Mehler J. (1998) The bilingual brain. Proficiency and age of acquisition of the second language. Brain: Journal of Neurology, 121, 10, 841–1852.
Pliatsikas C. (2019) Multilingualism and brain plasticity. The Handbook of the Neuroscience of Multilingualism, Schweiter J. (ed.) Wiley Blackwell: Hoboken, 230–251.

Pliatsikas C. (2020) Understanding structural plasticity in the bilingual brain: The Dynamic Restructuring Model. Bilingualism: Language and Cognition 23,2, 459 - 471.

Pliatsikas C., Meteyard L., Veríssimo J., DeLuca V., Shattuck K., Ullman, M. (2020) The effect of bilingualism on brain development from early childhood to young adulthood. Brain Structure and Function 225,7, 2131-2152.

Pliatsikas C., DeLuca V., Moschopoulou E., Saddy J. (2017) Immersive bilingualism reshapes the core of the brain. Brain Structure and Function, 222, 1785–1795.

Pliatsikas C., DeLuca V., Voits T. (2020) The Many Shades of Bilingualism: Language Experiences Modulate Adaptations in Brain Structure. Language Learning 70, S2, 133-149.

Ratiu, I. and Azuma, T. (2014) Working memory capacity: is there a bilingual advantage?, Journal of Cognitive Psychology, 27, 1, 1-11.

Rodríguez-Pujadas A., Sanjuán A., Ventura-Campos N., Román P., Martin C., Barceló F., Costa A., Avila C. (2013) Bilinguals use language-control brain areas more than monolinguals to perform non-linguistic switching tasks. PloS One Journal, 8, e73028.

Sanchez-Azanza V., López-Penadés R., Adrover-Roig D. (2019) More similitudes than differences between bilinguals and monolinguals on speeded and demand-varying executive tasks. Language, Cognition and Neuroscience 0,0, 1-18.

Scarmeas, N., & Stern, Y. (2003) Cognitive reserve and lifestyle. Journal of Clinical and Experimental Neuropsychology, 25, 625-633.

Schlegel A., Rudelson .J, Tse P. (2012) White matter structure changes as adults learn a second language. Journal of Cognitive Neuroscience 24:1664–1670.

Sebastian, R., Laird, A., & Kiran, S. (2011) Meta-analysis of the neural representation of first and second language. Applied Psycholinguistics, 32, 799–81

Seo R., Stocco A., Prat C. (2018) The bilingual language network: Differential involvement of anterior cingulate, basal ganglia and prefrontal cortex in preparation, monitoring, and execution, NeuroImage, 174, 44-56

Sierra, J. (2008) Assessment of Bilingual Education in the Basque Country, in Cenoz, J. (ed.) Teaching Through Basque: Achievements and Challenges. Clevedon, Multilingual Matters, 39-47

Staff, R., Murray, A., Deary, I., Whalley, L. (2004) What provides cerebral reserve? Brain, 27, 1191-1199.

Singh, L., Fu, C., Tay, Z., Golinkoff, R. (2018) Novel Word Learning in Bilingual and Monolingual Infants: Evidence for a Bilingual Advantage. Journal of Child Development, 89, 183 - 198.

Stein M., Federspiel A., Koenig T., Wirth M., Strik W., Wiest R., Brandeis D., Dierks T. (2012) Structural plasticity in the language system related to increased second language proficiency. Cortex, 48, 458–465.

Stocco A., Yamasaki B., Natalenko R., Prat C., (2014) Bilingual brain training: a neurobiological framework of how bilingual experience improves executive function, International Journal of Bilingualism,18,1, 67–92.

Surrain S, Luk G (2019) Describing bilinguals: A systematic review of labels and descriptions used in the literature between 2005–2015. Bilingualism Language and Cognition 22, 401–415.

Tokuhama-Espinosa, T. (2008) Living Languages – Multilingualism across the Lifespan. Praeger: London.

ValdéS G. (2005) Bilingualism, heritage language learners, and SLA research: opportunities lost or seized? Journal of Modern Languages, 89, 410–426.

Valenzuela, M. J., & Sachdev, P. (2006a). Brain reserve and dementia: A systematic review. Psychological Medicine, 36, 441-454

Valenzuela, M. J., & Sachdev, P. (2006b). Brain reserve and cognitive decline: A nonparametric systematic review. Psychological Medicine, 36, 1065-1073

Warmington, M., kandrau-Pothineni, S. Hitch, G. (2020) Novel-word learning, executive control and working memory: A bilingual advantage, Bilingualism: language and Cognition, 22,4,763-782.

Zirnstein M., van Hell J., Kroll J. (2019) Cognitive control and language ability contribute to online reading comprehension: Implications for older adult bilinguals. International Journal of Bilingualism 23,5, 971-985.

Zirnstein M., Bice K., Kroll J. (2019) Variation in language experience shapes the consequences of bilingualism. Bilingualism, Executive Function, and Beyond, 3, 35-47.

Zou L., Ding G., Abutalebi J., Shu H., Peng D. (2012) Structural plasticity of the left caudate in bimodal bilinguals. Cortex, 48, 1197–120.

ISBN 978-952-94-3995-9