Multilingual Education & Cognitive and Neurostructural Effects of Multilingualism

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MRI research

- Neuroimaging

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Overview

-Multilingual Education
  - Definition & Typology
  - The Belgian situation
  - Linguistic & academic effects
  - Students at risk?

-Neurocognitive and -structural effects of multilingualism
  - Cognitive flexibility
  - A lexical deficit?
  - Neural L2 and language control representation
  - Bridging multilingualism and cognition
  - Neurostructural effects of multilingualism
-fifty centuries of multilingual education (Glys Jones, 1977)
  – Ancient Mesopotamia, Hittite Kingdom, ...
-knowledge of Greek prestigious in Roman empire
  – Greek interference in 1st-century Latin
-Comenius on language pedagogy
  – La porte ouverte sur des langues (1631)
Reasons in 21st century

- growing globalization business & commerce
- revolution in electronic communications
- voluntary migration of people
- socio-political era promoting linguistic diversity
Definition

- Using 2 or more languages as media of instruction
  - Aim is to promote bilingual competence
- Integration of language and content
  - Not language - but content-driven instructional approaches
Population

-Speakers of majority languages
  - Also called « immersion »
  - English in Quebec, French in Flanders, ...

-Speakers of minority languages
  - Migrant languages
    - Spanish in Texas, Turkish in Brussels, ...
  - Indigenous languages
    - Maori in New Zealand, Native Americans in US, ...
Focus on immersion

- European context
- Content and Language Integrated Learning (CLIL)
- Precedents in immersion programs North America
- Education through minority language (Wales, Spain, ...)

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Focus on immersion

- Inclusive approach
  - No distinction between majority and minority language speakers

- Efficient for anyone?
  - Starting from common aims (knowledge target language) instead of starting from different linguistic background
Types of immersion

- **total immersion**
  - Almost 100% L2

- **partial immersion**
  - Around 50% L2
  - But language sociological environment should be taken into account

- **two-way, dual immersion**
  - Ideally 50% L1 or L2

- **FLES**
  - 15 to 50% L2

- **FLEX**
  - Introduction to L2 through L1
USA vs Belgium

-Belgium has three Regions

- Flanders  
  - 6,1m inhabitants

- Walloonia  
  - 3,4m inhabitants

- Brussels  
  - 1,2m inhabitants
USA vs Belgium

-and three Communities

- Dutch-speaking
  - Flemish Region + Dutch-speaking Brusselers

- French-speaking
  - French-speaking Walloons + French-speaking Brusselers

- German-speaking
  - German-speaking Walloons
USA vs Belgium

-Dutch-speaking community
  - Obligatory French language learning from 5th year primary education (age 10) or 3rd year around Brussels (age 8)
  - Immersion only possible as short-term projects

-French-speaking community
  - Obligatory second language learning (Eng, Dtch or German) from 5th year primary education (age 10) or 3rd year in Brussels
  - Immersion English or Dutch possible in >200 schools

-German-speaking community
  - French language learning from kindergarten
USA vs Belgium

- Belgium is a multilingual country
- But bilingual education for minority language speakers does not exist
- And immersion is not allowed by legislation in the largest Region of the country
- This is due to past inequalities that are still used as fuel for current linguistic tensions
Effects of Multilingual Education

- Linguistic development
- Academic achievement
- Cognition
- Brain development
- Attitudes
- French immersion programs for English-speaking students in Quebec (Lambert & Tucker, 1972)
- replicated in other regions
- significantly more advanced levels of L2 proficiency than conventional L2 instruction
- comprehension skills more developed than production skills
L1 Development

-same level of proficiency in all aspects compared to students exclusive L1 instruction
-lag in development L1 literacy skills in early total immersion
-parity after 1 year of L1 « language arts » instruction
Academic achievement

- same as in L1 programs
  - Even if all content is being taught in L2
- but only if language of testing is language of instruction
  - Importance L1 academic instruction if content is taught through L2
Reasons for advantages

- learning improved through increased motivation
- learning in context
- language in real-life situations
- fluency more important than accuracy
Focus on meaning or form(s)?

-FoM takes advantage of children’s natural ability to learn language in authentic, meaningful and significant communication with others

-but sometimes they lack mastery of some formal aspects of language

-more exposure does not always mean more proficiency

-FoFs as a solution?
Focus on form or forms?

- instruction of linguistic structures within communicative context
- explicit focus on form more time efficient than implicit focus on form
- explicit teaching of forms that are relevant to student’s communicative needs
Age effects

-younger is better?
-natural language learning ability
-attitudinal openness
-opportunity for extended exposure?
-learning styles young learners fit effective L2 pedagogy
Age effects

-But also older immersion students tend to score very well on L2 tests
-Fully developed L1 leads to easy transfer
-self-selection
Age effects

- Decision when to start immersion is dependent on socio-cultural and political factors and different aims of multilingual education
  - Multilingual communities: early bilingual education
  - Monolingual communities: late bilingual education sufficient
  - Trilingual competence as aim: late bilingual education
Time effects

-more is not always better
  - Upper & lower limits to importance of time

-intensity of exposure rather than accumulated amount of exposure
  - The Peel study (1982)

-different pedagogical approaches to be taken into account
  - Individualized vs. group-centered approach
Students at risk?

What about...

– Low IQ pupils?
– L1 disabled students?
– Children from low SES families?
– Pupils from ethnic minorities?
Low academic ability

- Below-average IQ students score at the same level in immersion as in L1 programs
- Benefits in the form of enhanced L2 proficiency
- Early immersion more egalitarian than late immersion
L1 ability

- important predictor of school success?
- same pattern as with low IQ students
  - Same level L1 & academic achievement
  - Superior L2 proficiency
Why?

- increased learning motivation
- immersion takes advantage of universal or natural language learning abilities
- language learning within student-relevant context
Low SES families

- Similar pattern as with low IQ
- Academic ability and SES intercorrelated

-French immersion programs in Louisiana
  - Immersion and L1 programs with high concentration of poor students
  - Higher scores for immersion students on English and math tests
Ethnic group status

- English as L3...
  - African & Native Americans speak their own variant of the standard language
  - Hawaiian or Mohawk immersion programs, African-American students in French immersion

- Still the same pattern can be seen with these students
  - Similar L1 development & academic achievement
  - Advanced levels of L2 proficiency
Language typology

- Hebrew-French-English immersion in Montreal
- Hawaiian-English immersion in Hawaii
- Mohawk-English immersion in Montreal
- Estonian-Russian immersion in Estonia
LA in bilinguals

- early bilingual language exposure optimal for dual language development (Kovelmann & Petitto, 2002);
- simultaneous bilinguals from birth; linguistic milestones in each language achieved at same time (Holowka et al., 2002);
- L2 learners (age 2-9): morphological and syntactic fundamentals acquired within 1st year of exposure (Kovelmann & Petitto, 2003);
- stage-like development L2 learners (age 2-9) comparable to monolinguals (Kovelmann & Petitto, 2003);
- no negative effect of L2 on L1 (Petitto et al., 2003)
Paradigm shift

-detrimental to child’s cognitive abilities (Darcy, 1963)
- Semilingualism

-now: focus on potential benefits
- "the negative results of these studies as being associated with linguistic minorities, where the minority language was being replaced in some sense by the socially dominant one, while the studies that found a positive effect were associated with 'additive bilingualism,' a situation in which majority-language children acquire a second language." (Cummins, 1979)
Metalinguistic awareness

- Ability to consciously reflect about language
- Boosted in bilingual development
- Same referent, different words
  - Arbitrariness linguistic sign
    - Sound-symbol correspondence
    - Symbol-meaning correspondence
- Cognitive flexibility
Flexible Learning of Multiple Speech Structures in Bilingual Infants

Ágnes Melinda Kovács* and Jacques Mehler

Children acquire their native language according to a well-defined time frame. Surprisingly, although children raised in bilingual environments have to learn roughly twice as much about language as their monolingual peers, the speed of acquisition is comparable in monolinguals and bilinguals. Here, we show that preverbal 12-month-old bilingual infants have become more flexible at learning speech structures than monolinguals. When given the opportunity to simultaneously learn two different regularities, bilingual infants learned both, whereas monolinguals learned only one of them. Hence, bilinguals may acquire two languages in the time in which monolinguals acquire one because they quickly become more flexible learners.
Fig. 1. (A) Familiarization phase of experiment 1. Infants listened to trisyllabic speech items where either the first two syllables were identical (i.e., an AAB structure, as in “lo-lo-vu”) or the first and last syllables were identical (i.e., an ABA structure, as in “lo-vu-lo”). Speech items were followed by a toy appearing in one of two white squares that were displayed continuously on the screen. The location of the toy was predicted by the item’s structure (e.g., left square for AAB, and right square for ABA). (B) Test phase of experiment 1. Infants were presented with new AAB and ABA items, but no toy followed the speech items. We used an eye-tracker to measure where the infants expected the toy to appear. On the right, two scan paths of an infant are depicted on two trials. (C) Measures of learning for the two structures or the two voice cues. Left: Difference scores for first looks [(number of correct looks – number of incorrect looks) / (number of correct looks + number of incorrect looks)] related to the chance level of 0 for ABA and AAB structures (experiment 1: bilinguals, N = 22; monolinguals, N = 22); and for male and female voices (experiment 2: monolinguals, N = 20). Right: Difference scores for overall accuracy for bilinguals and monolinguals in experiment 1 and for monolinguals in experiment 2. Error bars represent SE.
- The Good
  - Executive functions

- The Bad
  - Lexical access

- The Indifferent
  - Working memory
Deficient lexical access

Distribution of PPVT Scores

- Monolingual (n=772)
- Bilingual (n=988)
Improved executive functioning

Simon Task

- Incongruent
- Congruent

Children (Martin-Rhee & Bialystok, 2007)

- Mean RT ms
- Congruent vs. Incongruent

Middle-aged (Bialystok et al., 2004)

- Mean RT ms
- Congruent vs. Incongruent

Older adults (Bialystok et al., 2004)

- Mean RT ms
- Congruent vs. Incongruent

Bilinguals faster on congruent and incongruent trials
FLiPP Project Holland

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Bilingualism and the brain

- Representation of language in the brain
- Representation of languages in the brain
- Representation of language control in the brain
Facts about the brain
Bilingual Language Processing: Where in the brain?
Bilingual Language Processing: Lexicon vs grammar

-Ullmans

Declarative/Procedural Model

– Declarative or explicit knowledge
  – Lexical knowledge L1

– Procedural or implicit knowledge
  – Grammatical or syntactic knowledge L1
Different localization

Procedural system
- Fronto-striatal network (Broca's area and the basal ganglia)

Declarative system
- Left temporal areas
  - Cf. regular vs. Irregular verbs
Clinical implications

- dysfunctions of basal ganglia affect procedural or grammatical processing
  - Parkinson’s disease
    - Motor activity suppressed
    - Difficulty in producing regular past tense
  - Huntington’s disease
    - Excess motor activity
    - Overuse of grammatical rule, past tense irregular verbs become regular
Implications for bilingualism

According to Ullmans model

different localization
lexicon/grammar L1

the same for early acquired L2

but not for late learned L2

grammar would also rely on declarative/explicit memory.
Critical Period Hypothesis

- biologically defined time frame during which L1 acquisition has to take place
- also true for successful (native-like) L2 learning?
- AoA as defining factor for explaining differences in brain activity during grammatical processing?
Neuroimaging to the rescue

-MRI used for localization of brain processes during grammatical processing

- Comprehension/reception
  - Artificial language
  - Natural language
    - Grammatical or syntactic judgment, sentence reading, auditory comprehension, ...

- Production
  - Natural language
    - Verb conjugation, sentence production, ...
Early vs late learners of Spanish

- regular vs irregular gender processing
  - gender marking by word ending or not
- English learners of Spanish
Localization languages in the brain

Source: Wartenburger et al., 2003
Lexical knowledge L2

-Lexical tasks being used in the scanner include:
  - Production
    - Word repetition, word completion, picture naming
    - Verbal fluency
  - Reception
    - Lexical decision (words vs. Non-words)
    - Semantic judgment or classification
Lexical Knowledge L2

- activation of frontal and temporal areas irrespective of AoA
- proficiency as defining factor
- low L2 proficiency leads to additional recruitment prefrontal cortex compared to L1 activity
Lexical representation in bilinguals

- structural overlaps L1 & L2 in mental lexicon
- are both L1 & L2 words active during word recognition?
  - Language selective or language nonselective access?
  - Interlingual homographs processing may elucidate this question
Lexical representation in bilinguals

A

Bilinguals, ELD

Bilinguals, GLD

Monolinguals, ELD

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Localization language in the brain

- Importance
- Contextual factors
- Like dominant language of environment

Source: Perani et al., 2003
Bilingual Language Processing: How does it develop?

- As long as proficiency $L1 > L2$
  - Differences in extent of activity
  - Differences in location of activity

- Proficiency $L1 = L2$
  - Neural convergence
Bilingual Language Processing: How to avoid conflict?

- Tasks that have been used:
  - Language translation
  - Language switching
  - Language selection in the face of prepotent interferences from a prepotent language

- Common cognitive load:
  - Inhibition Language A
  - Selection Language B
Bilingual Language Processing: How to avoid conflict?

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Language and cognitive control

-PFC: executive functions
  (metacognition, cognitive control)
  - Regulating thought, action & emotion
    - Inhibition inappropriate thoughts, distractions, actions, and feelings

-ACC: error detection & conflict monitoring
  - Receives information about stimulus, selects an appropriate response, monitors the action, and adapts behaviour

-caudate nucleus: control of motor and cognitive activity
Card sorting task


PAPER

Attention and inhibition in bilingual children: evidence from the dimensional change card sort task

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Abstract

In a previous study, a bilingual advantage for preschool children in solving the dimensional change card sort task was attributed to superiority in inhibition of attention (Bialystok, 1999). However, the task includes difficult representational demands to encode and interpret the task stimuli, and bilinguals may also have profited from superior representational abilities. This possibility is examined in three studies. In Study 1, bilinguals outperformed monolinguals on versions of the problem containing moderate representational demands but not on a more demanding condition. Studies 2 and 3 demonstrated that bilingual children were more skilled than monolinguals when the target dimensions were perceptual features of the stimulus and that the two groups were equivalent when the target dimensions were semantic features. The conclusions are that bilinguals have better inhibitory control for ignoring perceptual information than monolinguals do but are not more skilled in representation, confirming the results of the original study. The results also identify the ability to ignore an obsolete display feature as the critical difficulty in solving this task.
Wisconsin card sorting task

- measure of executive functioning
  - Reported sensitivity to frontal lobe dysfunction
- significant activation of dorsolateral and ventrolateral prefrontal cortex and caudate nucleus (Berman et al., 1995; Cabeza & Nyberg, 2000)
Bilingual Language Processing: Effect on cognitive control?

-Bilingual advantage (Bialystok et al., 2004)

What did Simon say? Revisiting the bilingual advantage
J. Bruce Morton and Sarah N. Harper

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On the bilingual advantage in conflict processing: Now you see it, now you don’t

Albert Costa a,c,*, Mireia Hernández b, Jordi Costa-Faidella b, Núria Sebastián-Gallés c
Neurostructural effects of multilingualism

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Neurostructural effects of multilingualism

- Increased grey matter density in bilinguals
- Correlates with AoA and proficiency
- Link with fluency?
Neurostructural effects of multilingualism
Neurostructural effects of multilingualism
Thank you for your attention

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