Investigating the age factor with multiple measurements over time

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"Early Language Learning: What it (can) look(s) like…" University of Cambridge
October 25, 2019
“All of the most relevant questions about SLA, including the age issue, L1 influence, individual differences, implicit versus explicit learning, the role of input, intentional versus incidental learning, and of course the order of acquisition of morphosyntax, are implicitly or explicitly about change over time.”

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(Lowie & Verspoor 2015: 78)
“Applied linguistics […] ‘gone complex’” (Hiver & Al-Hoorie 2019)

Various rubrics such as chaos theory (Larsen-Freeman, 1997), emergentism (Ellis & Larsen-Freeman, 2006, 2009), dynamic usage-based theory (Langacker 2009), dynamic systems theory (de Bot et al., 2007; Verspoor et al., 2011) and complexity theory (Larsen-Freeman & Cameron, 2008)
Dynamics of intra-individual variation a necessary condition for development

(Meta)theories of change as well as relational theories

1. Language is interrelated with and embedded in our cultural, sociological and psychological lives. (see Verspoor, 2017; Five Graces Group, 2009)

2. Learning as a non-linear process rather than a product (> dense measurements).

3. The meaningfulness of free, non-systematic intra-individual variation
   - Increased variability coincides with a developmental jump i.e. a large amount of variability signals that the learner is apparently trying things out and that the subsystem under consideration is unstable. (Lowie et al. 2015; Lowie, de Bot & Plat 2014; Spoelman & Verspoor, 2010; van Dijk, Verspoor, & Lowie, 2011; van Geert & Verspoor 2015; Waegenmaekers et al. 2014)
   - “if there is no variability, there can be no development” (Lowie & Verspoor 2015: 76).
The age factor: a complex, socio-cultural variable

Age is a ‘linguistic glutton”: much of the effect of starting age is the consequence of its co-varying relationship with non-biological factors. (Muñoz & Singleton, 2011)

– Multicausality

“Life rather than age” (David Singleton, p.c., 2012)

• The current consensus among cognitive scientists is that the brain remains plastic throughout life, and that the brain is modified by experience at any age (Green 2018; Pascual-Leone et al. 2005; Pfenninger & Singleton, 2019; Schlegel et al. 2012).

• ‘chronological age’ and ‘social/contextual age’ (see Coupland et al., 1991)

Age effects are susceptible to…

– … learning context (schools vs. immersive settings at home vs. target culture) (Blom & Paradis 2016; Pfenninger 2017; Unsworth et al. 2012)
Rationale

HOW more important than WHEN


- “rich and plentiful input” (Florence Myles, p.c. 24/10/2019)

- Problem: Time is one of the most valuable pedagogical resources and the most hotly contested.

> Content and Language Integrated Learning (CLIL) i.e. bilingual language instruction (see e.g. Cenoz et al., 2014; Coyle et al., 2010; Dalton-Puffer & Smit, 2013; Dalton-Puffer et al., 2011; Hiligsmann et al., 2013; Juan-Garau & Salazar-Noguera, 2015; Kersten et al., 2010; Muñoz, 2012)

Studies on time and timing in CLIL are still lacking despite the Europe-wide implementations of early start policies and private and public early bilingual schools.
Study “Age and Immersion” (AIM)
Swiss pre/primary schools
Continuum of learning contexts:

<table>
<thead>
<tr>
<th>Regular FL instruction (MIC)</th>
<th>50:50 CLIL (PAC) (bilingual instruction)</th>
<th>Natural lg. acquisition</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Netherlands (e.g. Unsworth et al., 2012)</td>
<td>Bylund et al. (2019)</td>
<td></td>
</tr>
<tr>
<td>Switzerland (Pfenninger &amp; Singleton, 2017)</td>
<td>Vanhove (2013)</td>
<td></td>
</tr>
<tr>
<td>Spain (e.g. Garcia-Mayo, 2003; Muñoz, 2006, 201)</td>
<td>DeKeyser (2012)</td>
<td></td>
</tr>
<tr>
<td>France (Genelot, 1997)</td>
<td>Birdsong (2014)</td>
<td></td>
</tr>
<tr>
<td>Hungary (e.g. Baidak et al., 2012)</td>
<td>Stölten et al. (2016)</td>
<td></td>
</tr>
<tr>
<td>Germany (Jaekel et al., 2017)</td>
<td>Munro &amp; Mann (2005)</td>
<td></td>
</tr>
<tr>
<td>Japan (Harada, 2014; Larson-Hall, 2008)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>China and South Korea (Feng, 2012; Nunan, 2003)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taiwan (Huang &amp; Chang, 2015)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malaysia and Vietnam (Baldauf et al., 2011)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mexico, Argentina (SEP, 2011; Zappa-Holman et al., 2007)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada (Swain and Lapkin, 1987)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Research questions

INTER
1. Can age of first CLIL exposure predict L2 development in children who are educated in bilingual schools (height of the trajectories)?
2. How does AO predict variability in change over time (shape of the trajectories)?

INTRA
3. When do we find jumps in the developmental patterns of different AO groups?
4. To what do learners attribute watershed changes in L2 oral and written performance observed in the data? I.e., how do they explain the significant ebbs and flows in their L2 development over the 4–8 years of CLIL instruction?

*The study does not focus on between-program comparisons across programs but on age effects within programs.*
The granularity of focus that is implied by the RQs

Mixed methods approach: Nomothetic (quantitative) approach in combination with an idiodynamic (qualitative) approach

• A mixed methods approach (1) does justice to the complexity of the phenomena under investigation, and (2) it allows for surprising inductive discoveries of possible effects (Hiver & Al-Hoorie 2019)
Research design

Two-stage study:

2 Cross-sectional (INTER):
German, English and French written and oral skills of 251 students who varied in their age of first CLIL instruction onset (5, 7, or 9) at the end of primary education (age 12)

• 105 MIC (AO 7, 9)
• 146 PAC (AO 5, 7, or 9)

1 Longitudinal (INTRA): 91 tested four times annually over up to 8 school years (age 5–12)
### PAC participants in longitudinal part

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of subjects (sex)</th>
<th>L1 (home lg.)</th>
<th>L2</th>
<th>Age of first CLIL instruction onset</th>
<th>Age of French MIC onset (2 hrs/week)</th>
<th>No. of measurements (4 times/year)</th>
<th>No. of measurements (4 times/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 earlyPAC</td>
<td>25 (15 F)</td>
<td>German</td>
<td>English</td>
<td>5</td>
<td>11</td>
<td>32</td>
<td>800</td>
</tr>
<tr>
<td>2 midPAC</td>
<td>24 (12 F)</td>
<td>German</td>
<td>English</td>
<td>7</td>
<td>11</td>
<td>24</td>
<td>576</td>
</tr>
<tr>
<td>3 latePAC</td>
<td>22 (14 F)</td>
<td>German</td>
<td>English</td>
<td>9</td>
<td>11</td>
<td>12</td>
<td>264</td>
</tr>
<tr>
<td>4 earlyPAC-int</td>
<td>20 (11 F)</td>
<td>English</td>
<td>German</td>
<td>5</td>
<td>11</td>
<td>32</td>
<td>640</td>
</tr>
</tbody>
</table>

matched for SES; *not* matched for cognitive abilities!
**Tasks**

Oral production tasks: narrative re-telling tasks

Written production tasks: narrative, argumentative and descriptive essays in German and English

- matched for genre and topic & measurement invariance (see e.g. Bergh & Evers-Vermeul, 2017; Penris & Verspoor, 2017)
I'm making cookies and it is sunny.
Tasks

Oral production tasks: narrative re-telling tasks

Written production tasks: narrative, argumentative and descriptive essays in German and English

• matched for genre and topic (measurement invariance (see e.g. Bergh & Evers-Vermeul, 2017; Penris & Verspoor, 2017)

Language awareness questionnaires and motivation/success scales

Interviews

Parental questionnaires

Teacher questionnaires
# Measures and coding

<table>
<thead>
<tr>
<th>Morphosyntactic complexity and fluency</th>
<th>Mean length of utterance (MLU)</th>
<th>number of morphemes per word</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluency (word count)</td>
<td>written text length in tokens for written data; pruned syllables per minute for oral data</td>
<td></td>
</tr>
<tr>
<td>Clause ratio</td>
<td>clauses/T-unit for writing (Bulté &amp; Housen, 2014); clauses/analysis of speech units (AS-unit) for oral language (Polat &amp; Kim, 2014)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lexical richness</th>
<th>Measure of Textual Lexical Diversity (MTLD) (McCarthy &amp; Jarvis, 2010)</th>
<th>average number of words in a row for which a certain TTR is maintained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>Error-free units (Polio &amp; Shea, 2014)</td>
<td>total number of error-free T-units/AS-units</td>
</tr>
</tbody>
</table>
Stage 1: Longitudinal

Measurements

Written lexical richness (MLR)

earlyPAC

P01 - P14
P02 - P15
P03 - P16
P04 - P17
P05 - P18
P06 - P19
P07 - P20
P08 - P21
P09 - P22
P10 - P23
P11 - P24
P12 - P25
P13

earlyPAC_int

P72
P73
P74
P75
P76
P77
P78
P79
P80
P81
P82
P83
P84
P85
P86
P87
P88
P89
P90
P91

midPAC

P26 - P38
P27 - P39
P28 - P40
P29 - P41
P30 - P42
P31 - P43
P32 - P44
P33 - P45
P34 - P46
P35 - P47
P36 - P48
P37 - P49

latePAC

P50 - P61
P51 - P62
P52 - P63
P53 - P64
P54 - P65
P55 - P66
P56 - P67
P57 - P68
P58 - P69
P59 - P70
P60 - P71

Measurements
The challenge of analysis: Generalized additive mixed modeling (GAMM)

1. Nested dependencies (within-group auto-correlation in cluster-randomized designs)
2. Multivariate data: We measure more than one aspect from each individual (e.g. accuracy and fluency of L2 production).
3. Repeated measures: Multiple observations are nested within the individual, such as accuracy of L2 use over time.
   - Mutual dependence of consecutive time points (observations taken repeatedly across individuals)
4. Focus on the learner as a developing system on their own, rather than as a generalized hypothetical representative of a larger sample
   - no false grouping assumptions
5. Complex nonlinear trajectories
6. Time series data as target of inferential statistics
### Results of the GAMM (written lexical richness)

**Table 1. Summary of the results of the GAMM model for the effects of time and age (with earlyPAC-int)**

| Parametric coefficients | Estimate | Std.Error | t-value | Pr(>|t|) |
|-------------------------|----------|-----------|---------|---------|
| (Intercept)             | 10.42    | 14.92     | 0.70    | 0.489   |
| Smooth terms:           |          |           |         |         |
| s(Time)                 | 1.00     | 1.00      | 45.43   | <0.001*** |
| s(Age)                  | 1.97     | 2.00      | 16.60   | <0.001*** |
| ti(Time, Age)           | 2.97     | 3.50      | 89.47   | <0.001*** |
| s(AO)                   | 1.49     | 1.51      | 5.34    | <0.001*** |
| s(Time, Subject)        | 1.00     | 1.00      | 5.85    | 0.016*   |
| s(Time, Group)          | 8.92     | 10.00     | 33.79   | <0.001*** |

* Asterisks indicate significance of
  * p < .05  
  ** p < .01  
  *** p < .001

**Table 2. Summary of the results of the GAMM model for the effects of time and age (without earlyPAC-int)**

| Parametric coefficients | Estimate | Std.Error | t-value | Pr(>|t|) |
|-------------------------|----------|-----------|---------|---------|
| (Intercept)             | 11.98    | 16.54     | 0.72    | 0.469   |
| Smooth terms:           |          |           |         |         |
| s(Time)                 | 1.00     | 1.00      | 222.29  | <0.001*** |
| s(Age)                  | 1.97     | 2.00      | 16.97   | <0.001*** |
| ti(Time, Age)           | 1.00     | 1.00      | 80.83   | <0.001*** |
| s(AO)                   | 1.49     | 1.49      | 1.55    | 0.118   |
| s(Time, Subject)        | 1.93     | 2.00      | 7.65    | 0.001**  |
| s(Time, Group)          | 6.27     | 7.00      | 1658    | <0.001*** |

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| Parametric coefficients: | Estimate | Std.error | t-value | Pr(>|t|) |
|--------------------------|----------|-----------|---------|----------|
| (Intercept)              | 233.69   | 89.18     | 2.62    | 0.009**  |
| Smooth terms:            |          |           |         |          |
| Edf                      |          |           |         |          |
| Ref.df                   | 1.00     | 1.62      | 10.41   | 0.001**  |
| (Time)                   | 3.47     | 3.70      | 25.38   | < 0.001*** |
| s(Age)                   | 1.91     | 1.93      | 12.21   | < 0.001*** |
| s(Time, Subject)         | 1.99     | 2.00      | 34.39   | < 0.001*** |
| s(Time, Group)           | 7.25     | 10.00     | 33.34   | < 0.001*** |

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Overall AO effects

Written and oral fluency (text length i.e. word count)

Written and oral accuracy (error-free T-/AS-units)

Oral lexical richness (MTLD)

No overall AO effects

Written and oral complexity I (clauses per T-/AS-unit)

Written and oral complexity II (MLU)

Written lexical richness (MTLD)
Let’s marry QUANT and QUAL…

Focus on perturbations that trigger a significant change to the system (see Larsen-Freeman & Cameron 2008), as indicated by the quantitative data (periods of significant growth).
Individual predictions
I can't believe I did it, it's so nice and beautiful to hear or read that's the last time.

Development_P1_earlyPAC

Lexical richness (MTLD)

Measurements

Example 1

I am happy

I want to write more.

I want to be famous.

I'm listening good to Jessica.

I would ride it more because it was in the nature so it was hard.

I did the sentences and got different words.

When I wrote the text, it was good.

Ride the letters.

After a setens q."

I need detail and had color, creative ideas. I also stayed on the topic.

add details to my words.
Example 3

I composed sentences using adjectives, verbs and nouns for precision, clarity and impact.

Lexical richness (MTLD)

Measurements

Development_P88_earlyPACint
Example 6

I see how my age my progress in English.

I liked it because it was the first time I met an English story.

I did much plans.

I had at the end of the story more ideas than before.

I started writing.

and my felangs are also really good.

my friends also read the story and they liked it.

I am most proud of this piece because I know much about cars and I know much about dogs so I had really good arguments to write about.
Qualitative analysis (software MAXQDA)

- What themes emerge in periods of significant growth?
- How do these themes differ from periods of no growth?
Qualitative analysis (software MAXQDA)

1. Affective states, such as emotions, willingness to communicate, anxiety, self-confidence, investment, attitudes to the topic at hand;

2. Students’ encounters with English outside of school (including domestic technologies and digital toys and games);

3. “People factor” (Lasagabaster 2017: 110), such as the interaction with a teacher, peer or a family member, and how they interact with students’ motivational flows;

4. Cognitive events, such as message assembly, focus, attention to details, structure of narratives and interpretation of meaning, the demand of other school subjects;

5. Strategies: adding punctuation, avoid rushing, pre-planning speech/writing, stylistic considerations.
The findings are not representative for a longer period of time.

**Coincidental time of the measurement** (any measurement before or after the focal point could have given a different picture)

Table 1. Linear mixed-effects regression models for the investigated dependent variables **at measurement 31**

<table>
<thead>
<tr>
<th>Fixed effect: AO</th>
<th>Estimate ± SE</th>
<th>t</th>
<th>Main effect p</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>1334.26±596.23</td>
<td>2.29</td>
<td>&lt;.0001**</td>
</tr>
<tr>
<td>Fluency</td>
<td>-83.50±88.88</td>
<td>-0.940</td>
<td>.227</td>
</tr>
</tbody>
</table>

Table 2. Linear mixed-effects regression models for the investigated dependent variables **at measurement 32**

<table>
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<th>t</th>
<th>Main effect p</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>158.19±45.79</td>
<td>3.45</td>
<td>&lt;.0001**</td>
</tr>
<tr>
<td>Fluency</td>
<td>-15.00±4.41</td>
<td>-3.46</td>
<td>&lt;.0001**</td>
</tr>
</tbody>
</table>
Stage 2: cross-section at the end of primary PAC:
• AO: $\beta=-15.00\pm4.41, t=-3.46, p<.0001^{**}$

MIC:
• AO: $\beta=-2.45\pm2.51, t=-0.98, p=0.172$

Linear mixed model:
*Fixed effects:*
- AO
- Time
- AO*Time
- Scores T1

*Random effects:*
- Classes
- Subjects
State 2: Cross-sectional at the end of primary

Linear mixed model:
- Fixed effects:
  - AO
  - Time
  - AO*Time
  - Scores T1
- Random effects:
  - Classes
  - Subjects

PAC:
- AO: $\beta=-7.58\pm6.38$, $t=-1.58$, $p=0.105$

MIC:
- AO: $\beta=-11.19\pm8.37$, $t=-1.34$, $p=0.285$
Strongest predictors

Motivation (dimensions: future visions, self-efficacy, emotions, willingness to communicate, anxiety, interest)

Motivation $\times$ Extracurricular exposure

Extracurricular exposure (0 never to 5 daily)
- amount of time spent in a (real/online) situation involving native speaker contact
- video games
- surfing the net/checking pages in English
- social media
- (learning) apps
- movies, series, YouTube
- songs
Summing up

Age-related research

1. While there is no significant difference between children who begin the partial CLIL program at the age of 5 and children with AO 7, children with AO 9 lag behind significantly throughout primary school with respect to overall height as well as shapes of their trajectories.

2. The performance of the international children (from English-speaking homes) is sgf. stronger compared to the children from German-speaking homes for all oral but few written measures.

3. Initially (from age 5 to 10), there are significant differences with respect to modality (development of L2 speaking vs. L2 writing).

4. Age effects are task-dependent, and, more importantly, dependent on the coincidental time of the measurement.
AO effects immersive contexts: a hybrid

CDST research

5. The learners do not initially show more variability: children show significant improvement in oral and written L2 development in the last 2.5 years of primary school, starting from age 10.

6. But: more variability seems to indicate more L2 growth.

7. The patterns observed at the level of the group do not seem to be representative for those displayed by the individual learners.

8. The application of an ecological and person-centred approach means not rejecting but rather complementing the L2 frameworks developed in recent decades.
Thank you!

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