Multidimensional SLA

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Outline of Talk

• Issues in SLA
• Multidimensionality of language
• Emergentism
• Competition
• Timeframes
• E-CALL
• Language Partner
SLA Issues

1. Implicit-Explicit vs. Timeframes
2. Proceduralization Deficit vs. Zoning
3. Critical Periods vs. UCM
4. Input-Output vs. Resonance
## Dimensions of Language

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Area</th>
<th>Processes</th>
<th>Theory</th>
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<tr>
<td>Audition</td>
<td>STG, IPG</td>
<td>Extracting phonemes</td>
<td>Statistical learning</td>
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<td>Articulation</td>
<td>BA44, motor cortex</td>
<td>Targets, timing</td>
<td>Resonance, gating</td>
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<td>Syntax</td>
<td>BA45,47</td>
<td>Slots, sequences</td>
<td>Item-based patterns</td>
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<td>Mental Models</td>
<td>BA47, DLPFC, MTG</td>
<td>Deixis, Perspective</td>
<td>Perspective, Roles</td>
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<td>Participation</td>
<td>Social system</td>
<td>Topics, turn-taking</td>
<td>Conversation Analysis</td>
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Dimensions in the brain

- Maps (tonotopic, somatotopic, lexicotopic, roles) -- exquisite connection between maps
- Functional neural circuits
  - articulation gated by lexicon, gated by syntax
  - incremental mental model construction
  - ongoing learning through hippocampal and basal ganglia systems
  - preservation of interaction through social circuit
- linkage to episodics, orthographics, gesture,
Emergentism

• Darwin: proliferation, competition, selection
• Structure and levels are emergent
• New constraints govern emergent levels
• Modern linguistics emphasizes emergence
  • Connectionism, Dynamic Systems
  • Usage-based linguistics
  • Construction Grammar, Embodied Cognition
  • Competing Motivations, Competition Model
Emergence: Classic Example

• \( \text{H} + \text{H} + \text{O} \Rightarrow \text{H}_2\text{O} \)
• \( \text{H}_2 \) and \( \text{O}_2 \) are gases, but \( \text{H}_2\text{O} \) is a liquid
• Water's properties do not emerge from its components but from constraints on the molecular level
• Why? Dipole moments trigger Van der Waals bonding
Proliferation, Competition, Selection

• Competition is fundamental:
  • Darwin, Edelman, Chicago Economics
  • Minsky, Eagleman – Society of Mind
  • PDP
  • Competition Model, Sociolinguistics

• Competition
  • brain areas are multifunctional
  • multiple pathways lead to processing
    • horse races
    • indeterminacy
    • variability
4 levels of Protein Folding
Timeframes for Proteins

• Primary, Secondary, Tertiary, Quaternary
• Building of Body Structures
• Interactions with Immune System
• Regulation of gene expression
• Evolution:
  • proliferation, competition, selection
Language is like Proteins

- It has levels where structure emerges
- Constraints operate on the levels
- Initial learning (consolidation) takes minutes or hours.
- After consolidation, long-term influences continue.
Meshing of space-time scales

Orloj of Prague -- 1490
Timeframes have their impact in the Moment of Communication
Data Capture

• (Nearly) all of the overlapping space-time frames show their effects and interactions in actual moments in time and space.
• timeframes = wheels = motives
• We can capture The Moment and The Place on video.
• We need BIG DATA
From Notecards to TalkBank to a Web of Data
Timeframes

1. Memory Frames
2. Processing Frames
   • Word Production
   • Word Perception
   • Sentence Production
   • Sentence Perception
3. Interactional Frames
4. Role Frames
5. Group Frames
6. Long-term frames
   • Diachronic
   • Phylogenetic
Meshing on Constructions

• *hun* - Helen de Hoop vs. Ronald Plasterk
• *Icelandic impersonal passive* - Joan Maling
• *die jenige and extraposition* - Strunk
• English Dative alternation - Bresnan&Wasow
• *flip up that little temporal lobe* - Koschmann
• Fifth Grade Statistics: dependable batteries
• så er det snart *torturtid* and gestural analysis
FrameSet #1: Memory (from Cognitive Neuroscience)

• Procedural and declarative systems
• Declarative is more lexical; procedural more syntactic
• Both systems lead to cortical storage
• Both systems are designed to operate across timescales to insure optimal information integration (Bayesian)
Consolidation Frames in Bees (Hippocampus in Humans)
Hippocampal Support

Wittenburg et al. 2002
Frontal Lobe Timeframes
Koechlin & Summerfield
Graduated interval recall: Timeframes of consolidation

Pimsleur 67
Issue #1: Explicit-implicit vs. Timeframes

• Initial attention is required for learning.
• Explicit instruction directs attention
• Memory systems then convert explicit representations to implicit representations
• This happens in both L1 and L2
Explicit => Implicit Transition; Timeframes of Consolidation

- Initial representation is explicit
- Stored examples form the database
- Hippocampal reentrant resonance
- Gang formation
- Hippocampal timeframes
  - Gaskell sleep studies
  - Squire, McClelland evidence for period of years
Frameset #2: Processing (aka Psycholinguistics)

- Word Production
- Word Perception
- Utterance Production
- Utterance Perception
- **Monitoring, Error Detection**
Issue #2: Proceduralization vs. Zoning

A representation

The same representation

A transformed representation

The transformed representation

Routing Operation 1

Routing Operation 2
With practice

Region 1

Region 2

Region 3

A representation

A representation that has been processed

Time

New routing

Operation
Proceduralization
Zoning and Practice

• Once forms are acquired, they can proceduralize through usage
• Educational games research shows that zoning can increase motivation and learning.
• This happens in a conversation when we stop paying attention to form.
• But we still may need a focus on form.
Processing of mental models (from Cognitive Linguistics)

- Frontal-parietal system for embodied cognition
- Perspective taking, shifting
- Affordances
- Space/time model construction
- Metaphoric projection to body and other affordances
Issue #3: Input vs Output

• Mental model formation requires Comprehensible Input
• But proceduralization requires opportunities to practice.
• So both are important, but timing is the issue.
• Potovský (1979) and Davy and MacWhinney (in press) show that early Output can distract and teach errors.
Frameset #3: Interaction (from Conversation Analysis)

- Gaze contact, posture alignment
- Sequencing, projection, completion, overlap
- Repair, correction, recasting, feedback (support)
- Variation sets, scaffolding (support)
- Repetition, imitation (support)
- Tracking this in SLA is a major challenge
Frameset #4: Roles

(aka Social Psychology and Sociolinguistics)

• Alignment
• Affiliation, family, clubs, religions (support)
• **Immigration, age stratification
• Memes
• Overlapping roles and goals with divergent space-time commitment frames.
• Overlapping involves meshing.
## Issue #4: Critical Periods

<table>
<thead>
<tr>
<th>Risks</th>
<th>Basis</th>
<th>Supports</th>
<th>Basis</th>
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</thead>
<tbody>
<tr>
<td>1. Entrenchment</td>
<td>Cortical Maps</td>
<td>Resonance</td>
<td>Hippocampus</td>
</tr>
<tr>
<td>2. Misconnection</td>
<td>White Matter</td>
<td>Proceduralization, Fluency</td>
<td>Thalamus, BG</td>
</tr>
<tr>
<td>3. Parasitism</td>
<td>Transfer</td>
<td>Internalization +</td>
<td>Inner Speech</td>
</tr>
<tr>
<td>4. Isolation</td>
<td>Social Stratification</td>
<td>Participation</td>
<td>Group Inclusion</td>
</tr>
</tbody>
</table>
Empirical and Theoretical Gap

- Surprisingly, Emergentist Theories have failed to examine interactions between language dimensions.
- This can be corrected by developing the theory of timeframe meshing.
- As with proteins, developing the theory requires BigData and models.
- Crucially, this theory can be elaborated through E-CALL.
E-CALL

• CALL is moving to the Web
• Mobile devices are bringing learning to the real world
• We at CMU are building support systems that deal with the multidimensional nature of language and learning
• Connected devices can provide
  • tutorial delivery
  • resource access
  • usage tracking, optimization
Language Partner

Interactive Media
- DOVE
- DataShop
  - Student Modeling
  - Classroom Linkage

Basic Skills Tutors
- Action Games*
- PinYin
- Characters
- Vocabulary
- Collocation
- Fluency

Devices
- 3G Tablets
- Laptops
- Networked Computers
- Camera Dictionary
- Recording with friends
- Shopping for treasures
- Museum guides

Situated Learning Activities
- Restaurant guides
- Google Map tours

Applications
- Internet TV
- DOVE
- Internet TV
- Networked Computers
Integration with classroom

• Hybrid System
  • Modules designed to achieve teacher buy-in
  • Modules off-load grading and skill exercises

• Open Data
  • Web permits complete data storage; open access as in DataShop
  • Computer control permits random assignment to treatment (hence E-CALL)

• Modules can be added by community
  • Based on core GWT technology
What we have been studying

• 15 studies published, 5 in progress
• 4 empirical/theoretical issues:
  1. Implicit-Explicit vs. Support
  2. Proceduralization Deficit vs. Zoning
  3. Input-Output vs. Resonance
  4. Critical Periods vs. UCM
Resources at talkbank.org

**Data**
- *Usage Ground Rules*
- Browsable Database
- Downloadable Database
- Database Manuals
- MetaMaker

**Focus Areas**
- BilingBank
- CABank
- CHILDES
- PhonBank
- Danish SamtaleBank

**Resources**
- Second Language Resources
- CLAN - Manual - Tutorial
- CLAN Workshop
- Other Software
- Picture Stimuli

**Clinical Areas**
- AphasiaBank
- DementiaBank
- TBIBank

**Information**
- Digital Video
- Digital Audio
- Research Usage
- Plans and Dreams

**Membership**
- Membership Lists
- Joining
- Contributing
- Mailing Lists
- IRB

Monday, June 17, 13
Direct Playback

@Loc: Eng-UK/Forrester/073.cha
@Begin
@Languages: eng
@Participants: E Ella Target_Child, F Mike
@Options: CA
@ID: eng|Forrester|E|1;5.|female|Target
@ID: eng|Forrester|F|Mother
@ID: eng|Forrester|M|Father
@Media: 73, video
@Transcriber: Silvia Sbaraini
@Time Duration: 0:26:57
@Situation: breakfast time talk

*F: hhh oh did it fall on the ground (1.4)
*F: hhh (0.5)
*F: d'you want to give some to Daddy (0.2)
*F: cough cough (1.8)
*F: thank you baby (0.4)
*F: thank* you (1.2)
This page provides links to online resources for practicing and consolidating second language. There are six groups of links:

- **PSLC**: Resources developed through PSLC activities
- **Learners**: Learner resources for specific skills
- **Systems**: Complete courses or learning systems
- **iPad**: Resources for use on the iPad and situated contexts.
- **Researchers**: Resources for researchers. Some may also be useful for learners.
- **Theory meets Application**: Matches between Competition Model postulates and instructional design used here.
Online Measures

The VILLA Study
(Varieties of Initial Learners in Language Acquisition)
Cognitive Tests

English
- Flanker
- Digit Span
- Number-Letter Sequencing

German
- Flanker
- Digit Span
- Number-Letter Sequencing

Dutch
- Flanker
Where does the data go?

- Data stored at CMU, simple CSV format
- Available immediately on instructor web pages
- Scores used as predictors of instructional treatment outcome
- Scores also used for HMM student models
- iPad Lingraphica data
- iPad data for AACBank
PSLC Basic Skills Studies

Yuki Yoshimura: Fluency testing

Colleen Davy: Fluency training

Nora Presson: French gender cues, Spanish conjugation, virtual world prepositions

Yanhui Zhang: Pinyin dictation tutor

Helen Zhao: English article tutor

Yueran Yuan: preposition games

Like Li: character tutor

Dan Walter: German case/gender cues
The Pinyin Tutor

Try the Pinyin Tutor Demo now

Register your class to use the Pinyin Tutor
Words match textbooks used in class; 4000 users across 42 sites
Virtual Reality for Spanish Prepositions:
Take the milk to the left of the plants and put it next to the box.
Spy Game - Yueran Yuan

- go to the door
- sneak past the guard
- give the file to the man in green
- put the chemicals on the desk
Vocabulary and Resonance

Interactive Activation and Gangs
Units that fire together, wire together
Resonance and Representations
Some people don't like tomato juice.

Green plants produce oxygen.

The government provides support for poor.

When did Stone Age end?

Time remaining: 24:32
Compare the two sentences: Why do they require different articles?

1) The two sisters were only interested in wealth of their parents.

Correct!
The rule to apply is: the-noncountable+clause/PP.

Use the when a non-countable noun is modified by a relative clause or a prepositional phrase.

2) The two sisters were only interested in wealth.

Wrong.
The rule to apply is: 0-noncountable.

Use 0 with unmodified noncountable nouns.

Your Accuracy: 80%
Time remaining: 25:47
(Page 5 of 13)
Competition Model – Cues

- Functions compete for forms
- Forms compete for functions
Cues

- specificity and uniqueness are not enough
- the Himalayas, but Lake Baikal
- the Gobi and the Pacific, but West Texas
- the Parker Building but Baker Hall
- the Avenue of the Americas, but Fifth Avenue
- friction secured it, but the friction on the pulley secured it
- the best actor (superlatives are unique)
Greatest gains for explicit feedback with transparent cues
Findings

1. When cues are clear, students learn quickly
2. Highly specific cues (lakes, halls) are clear, but have limited scope in practice
3. Exemplars are faster, but explanations lead to longer retention
4. Knowledge-tracing doesn’t help, because of the small training period.
Conjugate tener, preterite tense.

Person | Singular | Plural  
---|---|---
1st   | tuve   | tuvimos  
2nd   | tuviste | tuvistéis  
3rd   | tuvo   | tuvieron  

Second person plural "tuvistéis" is incorrect.
Cues

• The Competition Model emphasizes
  • cue reliability
  • cue availability
  • cue strength
  • cue cost

• The Presson studies demonstrate value of explicit cue training, time pressure, and proceduralization of explicit cues
Basic Fill-In with Feedback

Dans le laboratoire, il y a un ordinateur, des tables, et (___) CD-Roms.

Answer: des

Très bien!
Reports to Instructors

University of Southern Denmark

Pinyin Tutor Report

Format of each cell: (List of Highest Scores Obtained | Time on Task in Minutes)

<table>
<thead>
<tr>
<th>Student ID</th>
<th>Lesson 1</th>
<th>Lesson 2</th>
<th>Lesson 3</th>
<th>Lesson 4a</th>
<th>Lesson 4b</th>
<th>Lesson 4c</th>
<th>Lesson 5a</th>
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General Findings

• All tutors are massively better than control group
• They provide
  • high efficiency
  • high retention
• But instructional treatment comparisons are often not significant. Why?
  • treatments are sometimes "packages"
  • unconfounded treatment differences can be minor (highlighting, timing, # trials)
It's mine and Gina's 'round the world' night.
Configuring DOVE

• Video and subtitles from YouTube
• Movies with captions (fair use)
• Comprehension tested through automatically generated cloze (fill in the blanks)
Links to Web TV and Radio
iPad extensions

• Games: uTalk, RollingZilla, MindSnacks
• Dictionaries with SIRI (ECTACO TTS)
• Character training
• TV, radio on the iPad
• Chinese Menu tour
• Google Earth Tours
• Voice Memos; Camera; Web Voice in Java
• Monitors: GPS, finger sensor
iPad apps (in progress)
Character Tutor
talkbank.org/dimsum
Embedded (situated) communication

• Input is not enough
• Interactional and Role wheels must be exercised in real life situations
  • shopping
  • taking the bus
  • ordering food
  • planning trips
• Recordings (iRecorder) from the real world can be brought back to the classroom
Google Earth Tours
Adding Places and Paths
Tour on Street Map
Development

• Visit Pittsburgh, Beijing, Odense
• Triggering interactions inside tours through instructions to take buses, ask questions, buy things, take notes
• Support for bringing tours into classroom through audio and group discussion
E-CALL Data Types

- Within-subject designs for item-based issues (cue validity, frequency)
- Between-subjects designs for evaluating instructional treatments
- Latin Squares when items do not strongly interact (as in vocabulary)
- DataShop growth curve analysis
- User Preference and HCI analyses
Everything in one System

• Ability to switch between modules
• Recording of time on components, choices, answers, errors
• Central student model that knows what the student needs to practice
• Linkage to what is going on in the classroom
• Extensibility
Maybe

• Evaluation of the four issues requires realistic longitudinal data.
• maybe explicit teaching is ineffective,
• maybe L2 learners cannot proceduralize,
• maybe output is pivotal,
• maybe there is a Critical Period,
• maybe learners only need subtitled video,
• maybe some only need menus and tours
• maybe, .....
But

- We will not know based only on laboratory experiments.
- We must have longitudinal data.
- With opportunities for learners to select alternative support methods.
How can we build this?

• If it is designed in a modular fashion, people can add components. Software engineering.
• A system built for one language can be used for many.
• This should be an activity of the research community. Perhaps some big project.
• I would like to hear from ALL OF YOU
DuoLingo?
DuoLingo Features

- Created by Luis van Ahn - CAPTCHA
- Freely available at duolingo.com
- 250,000 users, mostly in Latin America
- Makes money through translating the web
- Provides
  - Vocabulary
  - Translation L1 \(\rightarrow\) L2, L2 \(\rightarrow\) L1
  - Dictation in L2
  - Fill-in the blank
  - Grammar feedback (increases buy-in)
DuoLingo Evaluation

• Vesselinov and Grego (December 2012)
• Also evaluated Rosetta Stone, Auralog, and Berlitz (unpublished)
• Study funded by Duolingo
• From the thousands of Spanish learners only 196 took WebCape and entered the study. Only 88 finished. Huge selection effect.
• Conclusion: Duolingo gain for these learners is about equal to classroom
Traditional SLA Research

• The language classroom
  • teacher’s time is divided across students
  • scoring assignments consumes teacher time
  • communicative approach deemphasizes skills
  • no way to focus on mastery

• Problems for experimentation
  • inconsistent administration
  • treatments confounded with instructor
  • no random assignment
  • SLA research resorts to metaanalysis
CALL

• CALL Courses
  • complete online courses have no teacher buy-in
  • complete courses are not really complete
  • Pearson, OLI don't care about experimentation
  • SecondLife is slow, complex

• Traditional CALL
  • Desktop CALL is no longer an option
  • Current WebCALL facilities have no experimental thrust
Photos, Audio, Texts
Target Audience

• Foreign students at CMU and Pitt (ELI) practicing English
• Foreign visitors to Pittsburgh
• English language learners (ELL) in the Pittsburgh public schools
• Native speaker visitors (visitpittsburgh.com)
• Assumes iPad with 3G wifi
• Based on Google Earth
Study Abroad

• Tours of Pittsburgh, Taipei, Beijing, and Barcelona
  • working with teaching faculty at each site
  • setting up teacher-friendly methods for constructing tours
  • linking tours to classroom discussion
  • focusing much more on embedding interactions inside tours through instructions to take buses, ask question, buy things, take notes