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

Subsystem	Area	Processes	Theory
Audition	STG, IPG	Extracting phonemes	Statistical learning
Articulation	BA44, motor cortex	Targets, timing	Resonance, gating
Lexicon	STG RH coding	Phonology to meaning	DevLex
Syntax	BA45,47	Slots, sequences	Item-based patterns
Mental Models	BA47, DLPFC, MTG	Deixis, Perspective	Perspective, Roles
Participation	Social system	Topics, turn-taking	Conversation Analysis

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

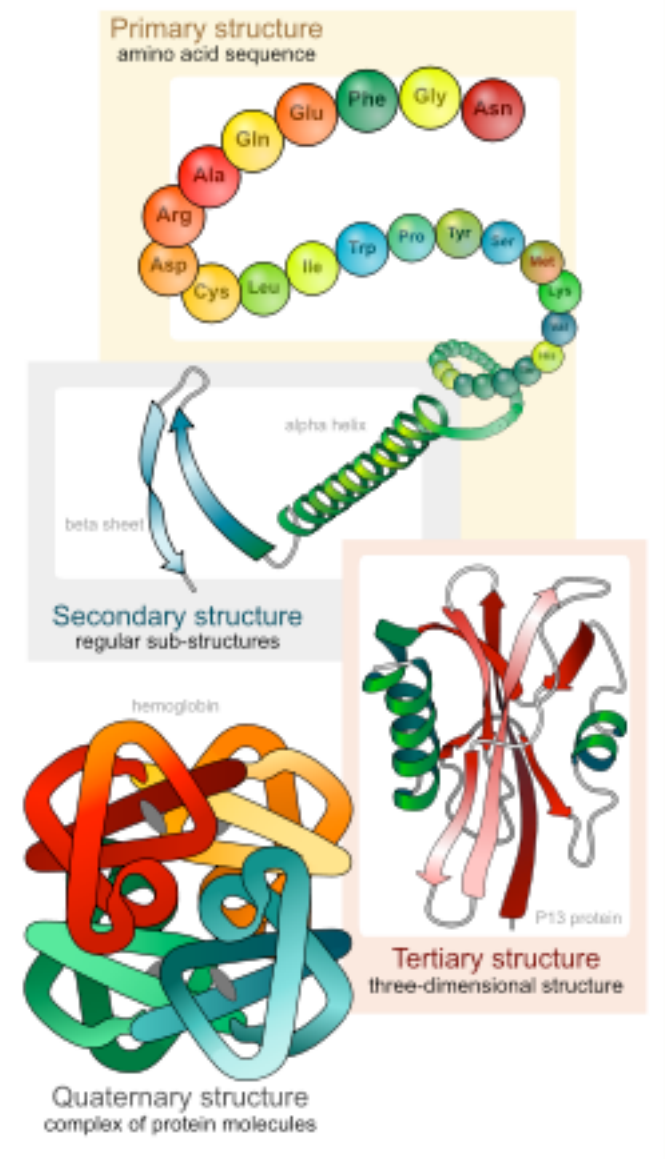
Emergence: Classic Example

- $H + H + O \Rightarrow H_2O$
- H_2 and O_2 are gases, but H_2O 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

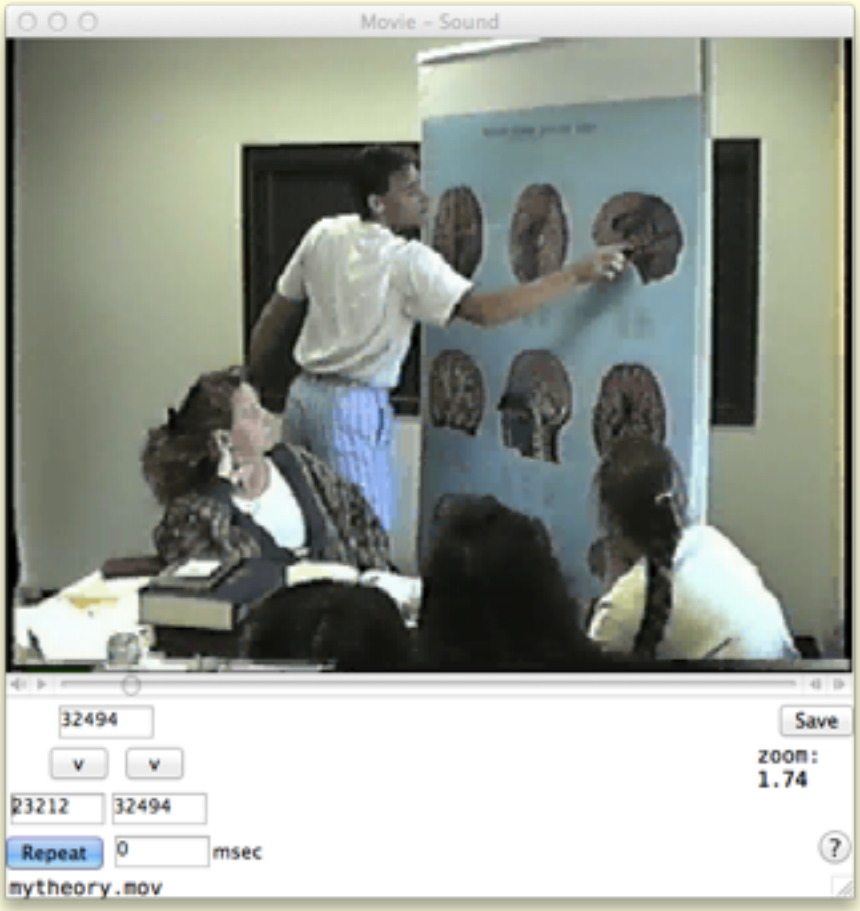
Language is like Proteins

- 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



/Brian/InterOp/mytheory/mytheory-orig.cha

```
*NOR:   ıIt's right ↓down there→ •
%gpx:   pointing with hand toward atlas from seat.
*NOR:   it's the bottom of this thing→ •
        (2.4) •
%gpx:   rises from chair and moves toward flipchart •
*NOR:   'ts right in here.•
%gpx:   Places forefinger of R hand on chart and twice
        traces the lower edge of a structure in the sagital section,
*NOR:   rightmost, second row→ •
        (0.8) •
*UNK:   Its unˈder → •
*MAR:         ıthink it's un:der.•
%gpx:   Norman returns to seat
*NOR:   It's under that↓  •
*MAR:   ++ I think it's on the inside→ •
*COA:   It's on the middle, •
        (0.3) •
        middle top→ •
```

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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

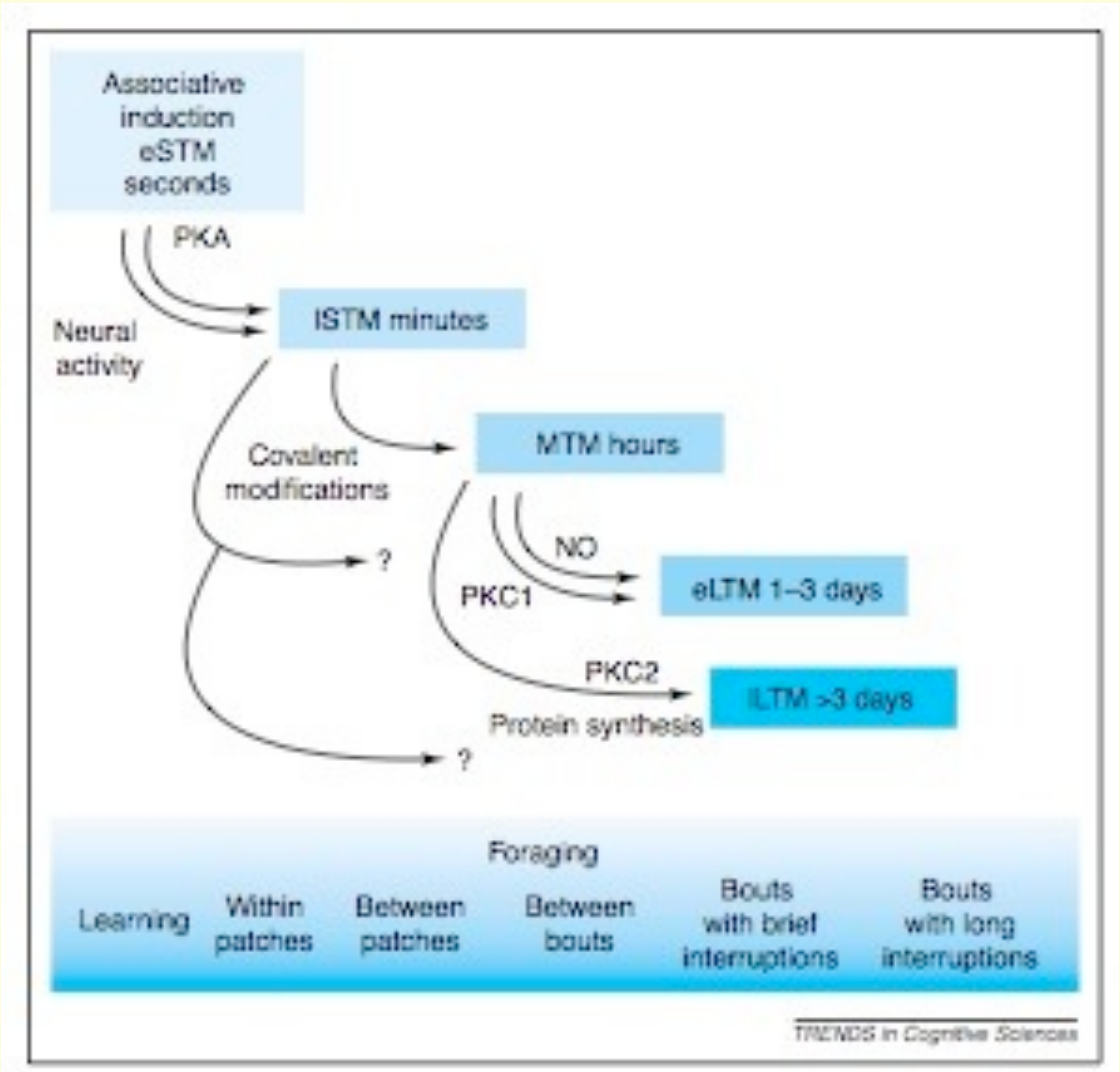
Meshing on Constructions

- *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)

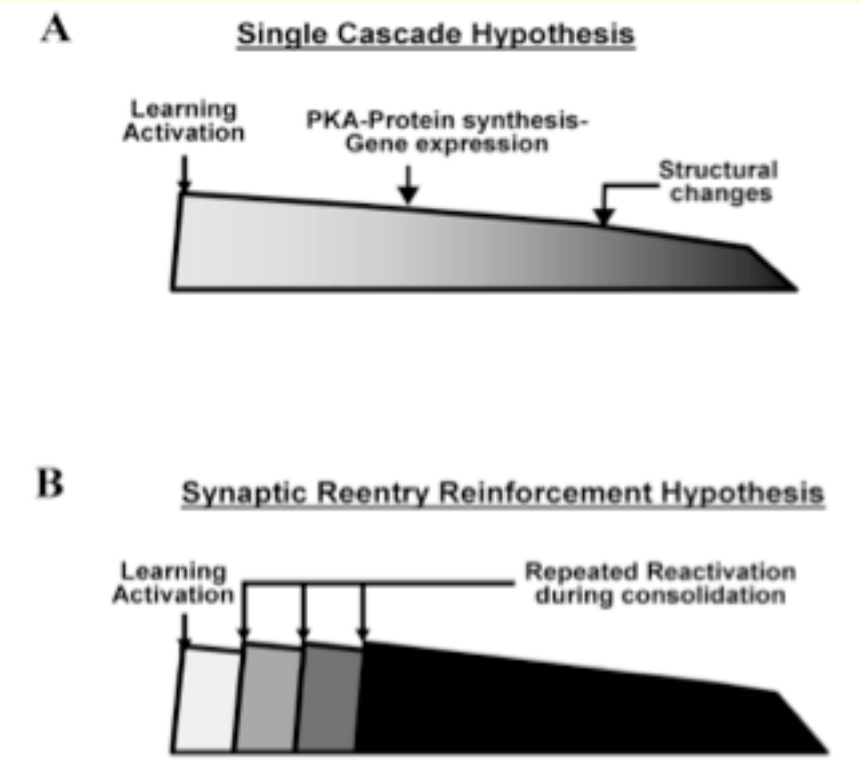
- Procedural and declarative systems
- Declarative is more lexical; procedural more syntactic
- Both systems lead to cortical storage
- Both systems are designed to operate across timescales to insure optimal information integration (Bayesian)

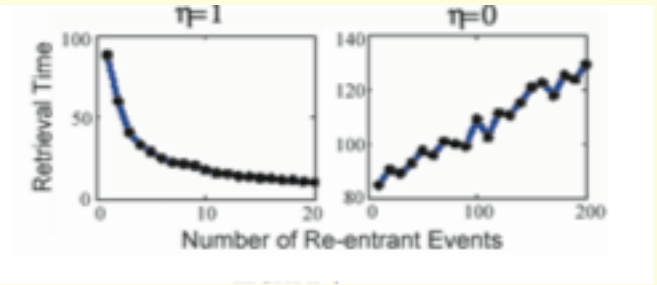
Consolidation Frames in Bees
(Hippocampus in Humans)



Hippocampal Support

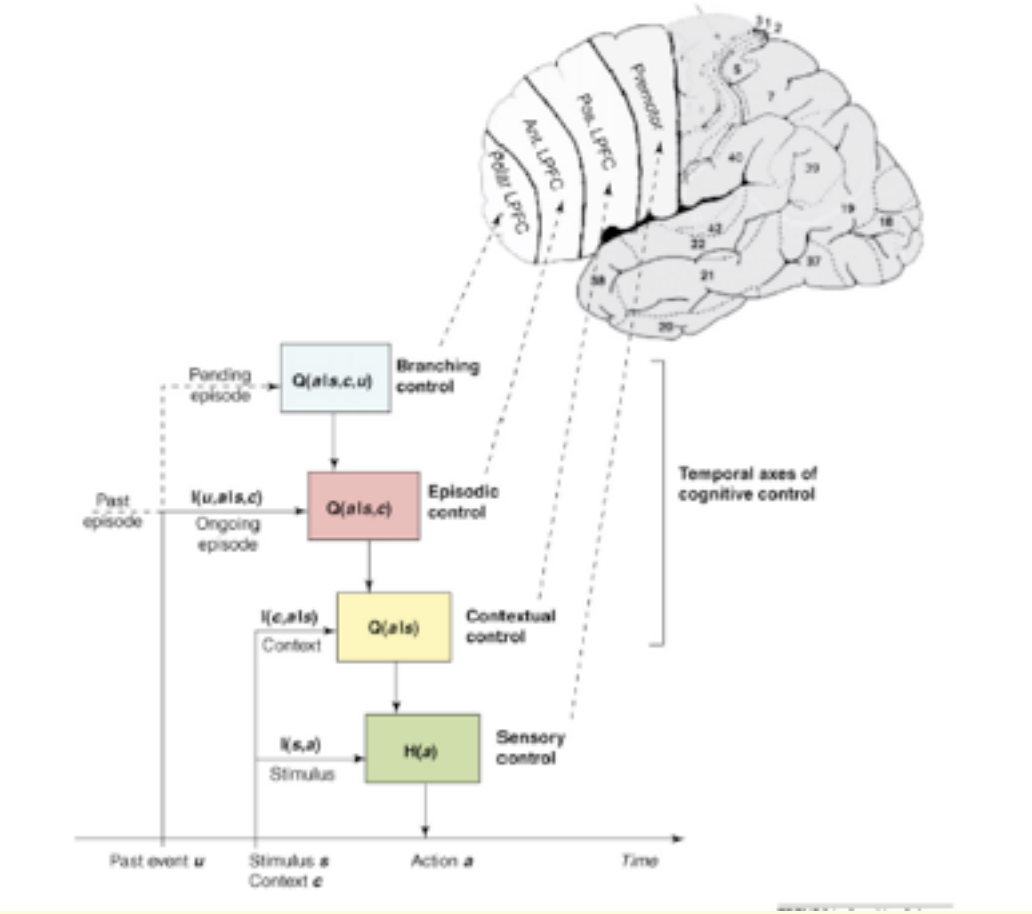
Wittenburg et al. 2002





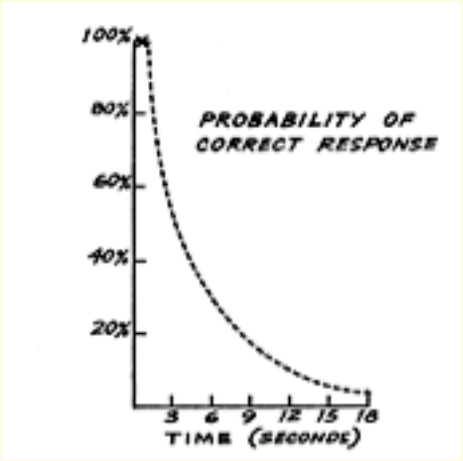
Frontal Lobe Timeframes

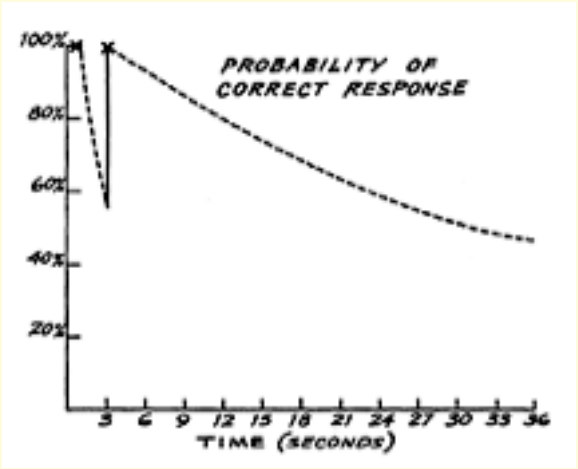
Koechlin & Summerfield

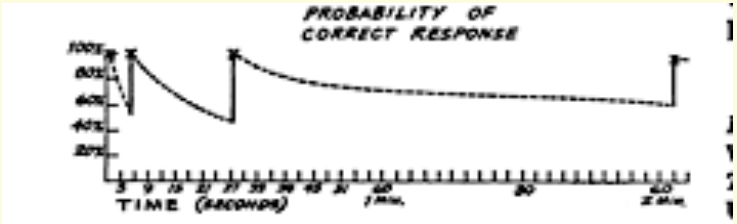


Graduated interval recall: Timeframes of consolidation

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

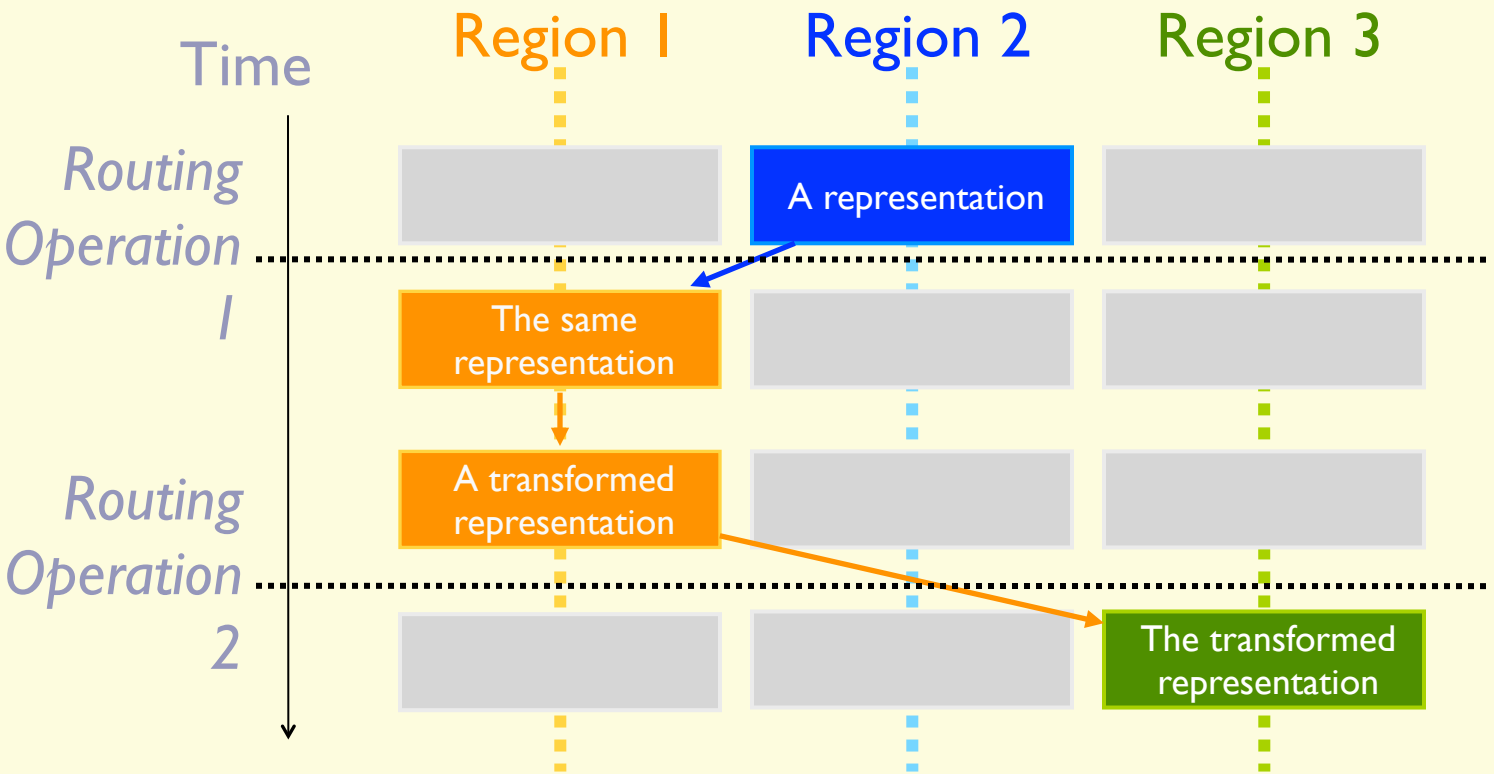
Explicit => Implicit Transition; Timeframes of Consolidation

- 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

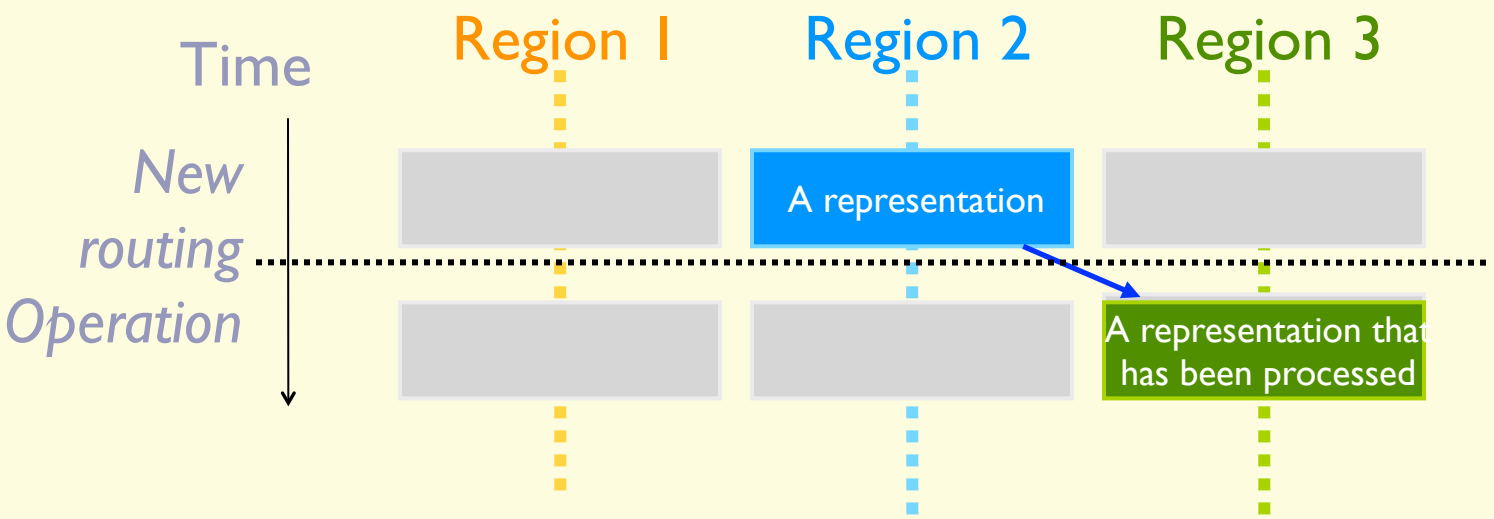
Frameset #2: Processing (aka Psycholinguistics)

- Word Production
- Word Perception
- Utterance Production
- Utterance Perception
- **Monitoring, Error Detection

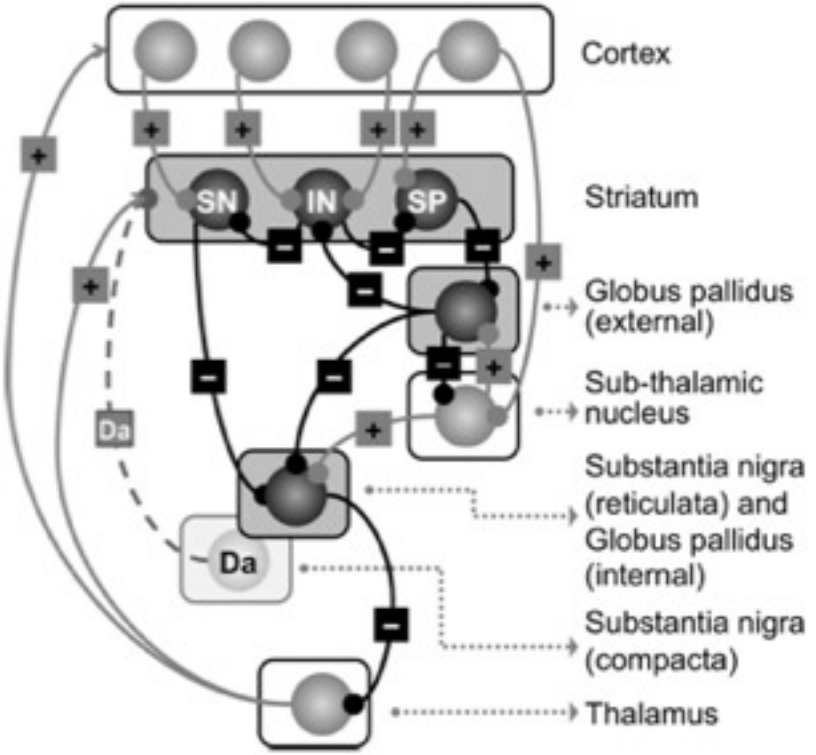
Issue #2: Proceduralization vs. Zoning

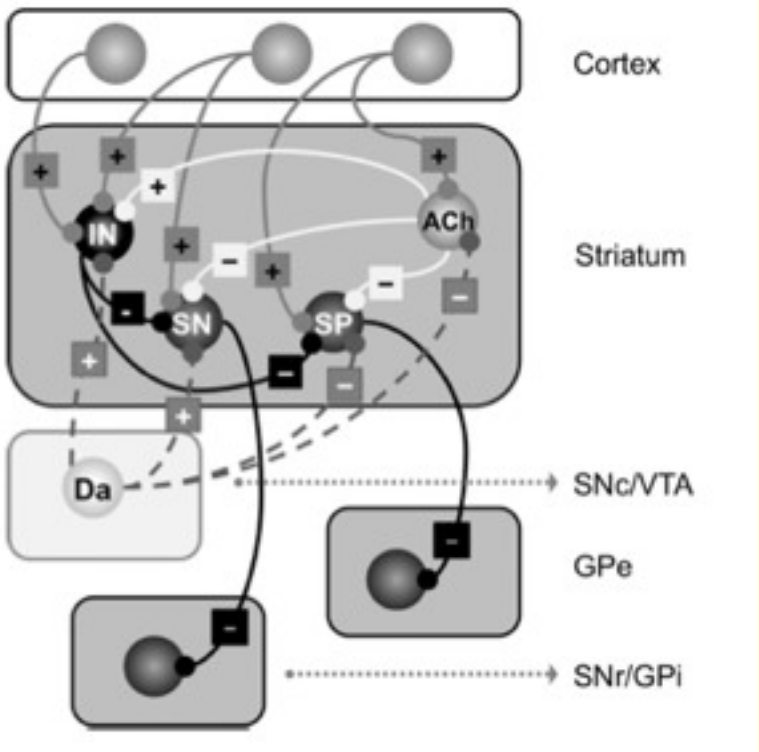


With practice



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.
- Potovsky (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

Risks	**Basis**	**Supports**	**Basis**
1. Entrenchment	Cortical Maps	Resonance	Hippocampus
2. Misconnection	White Matter	Proceduralization, Fluency	Thalamus, BG
3. Parasitism	Transfer	Internalization +	Inner Speech
4. Isolation	Social Stratification	Participation	Group Inclusion

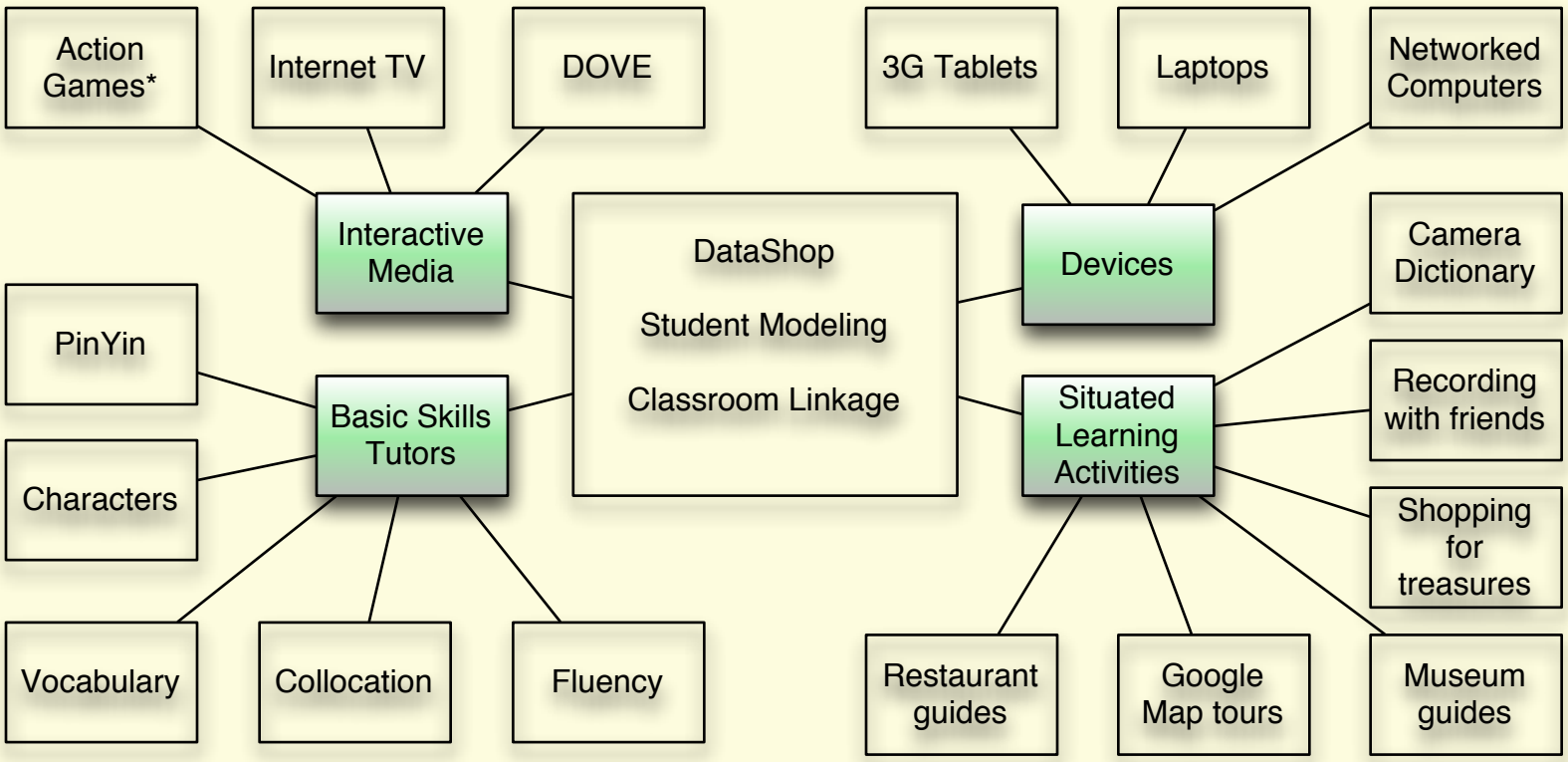
Empirical and Theoretical Gap

- 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



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:

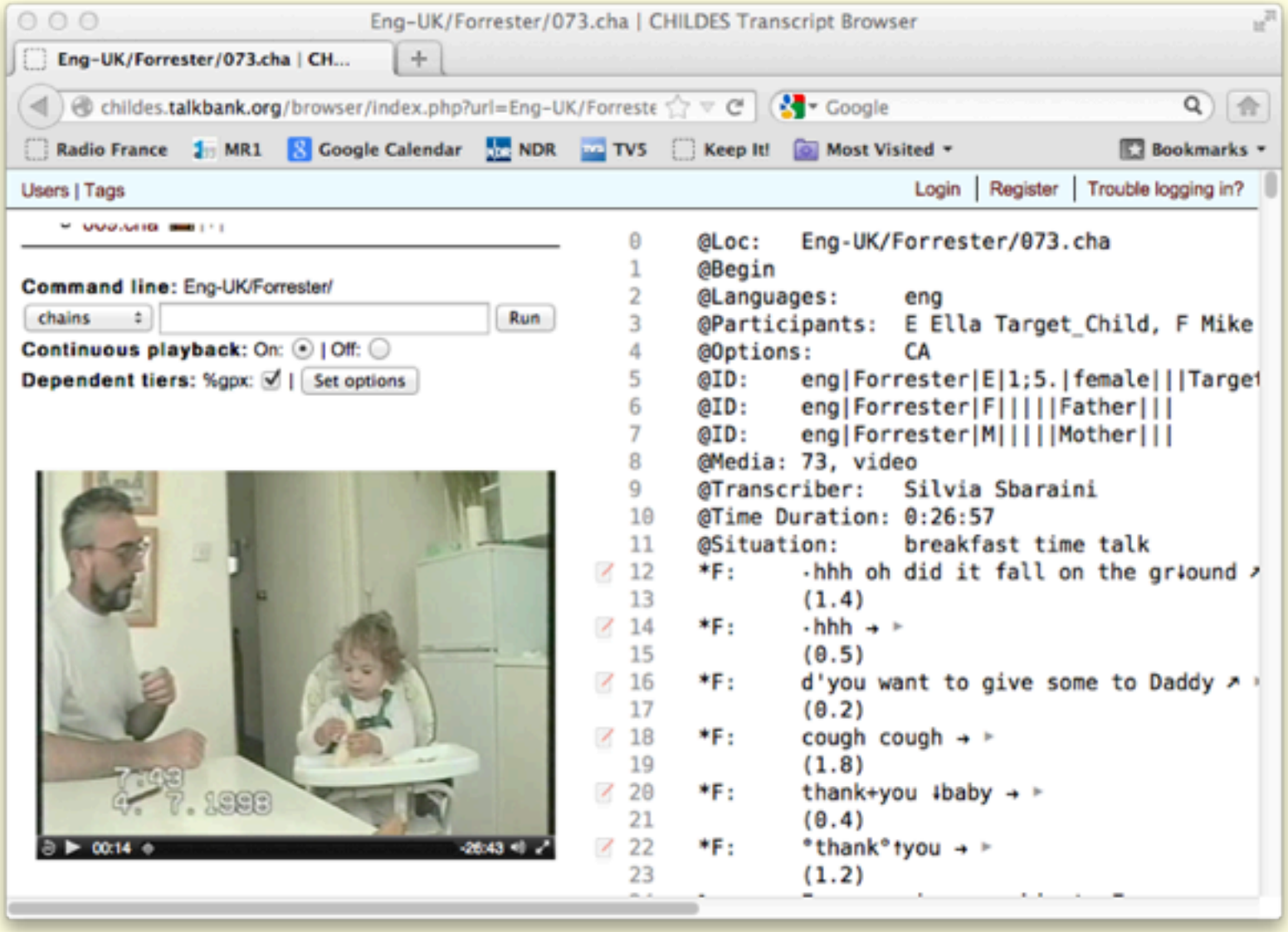
1. Implicit-Explicit vs. Support
2. Proceduralization Deficit vs. Zoning
3. Input-Output vs. Resonance
4. Critical Periods vs. UCM

Resources at talkbank.org

Data	Resources	Membership
Usage Ground Rules	Second Language Resources	Membership Lists
Browsable Database	CLAN - Manual - Tutorial	Joining
Downloadable Database	CLAN Workshop	Contributing
Database Manuals	Other Software	Mailing Lists
MetaMaker	Picture Stimuli	IRB

Focus Areas	Clinical Areas	Information
BilingBank	AphasiaBank	Digital Video
CABank	DementiaBank	Digital Audio
CHILDES	TBIBank	Research Usage
PhonBank		Plans and Dreams
Danish SamtaleBank		

Direct Playback



talkbank.org/SLA

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

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

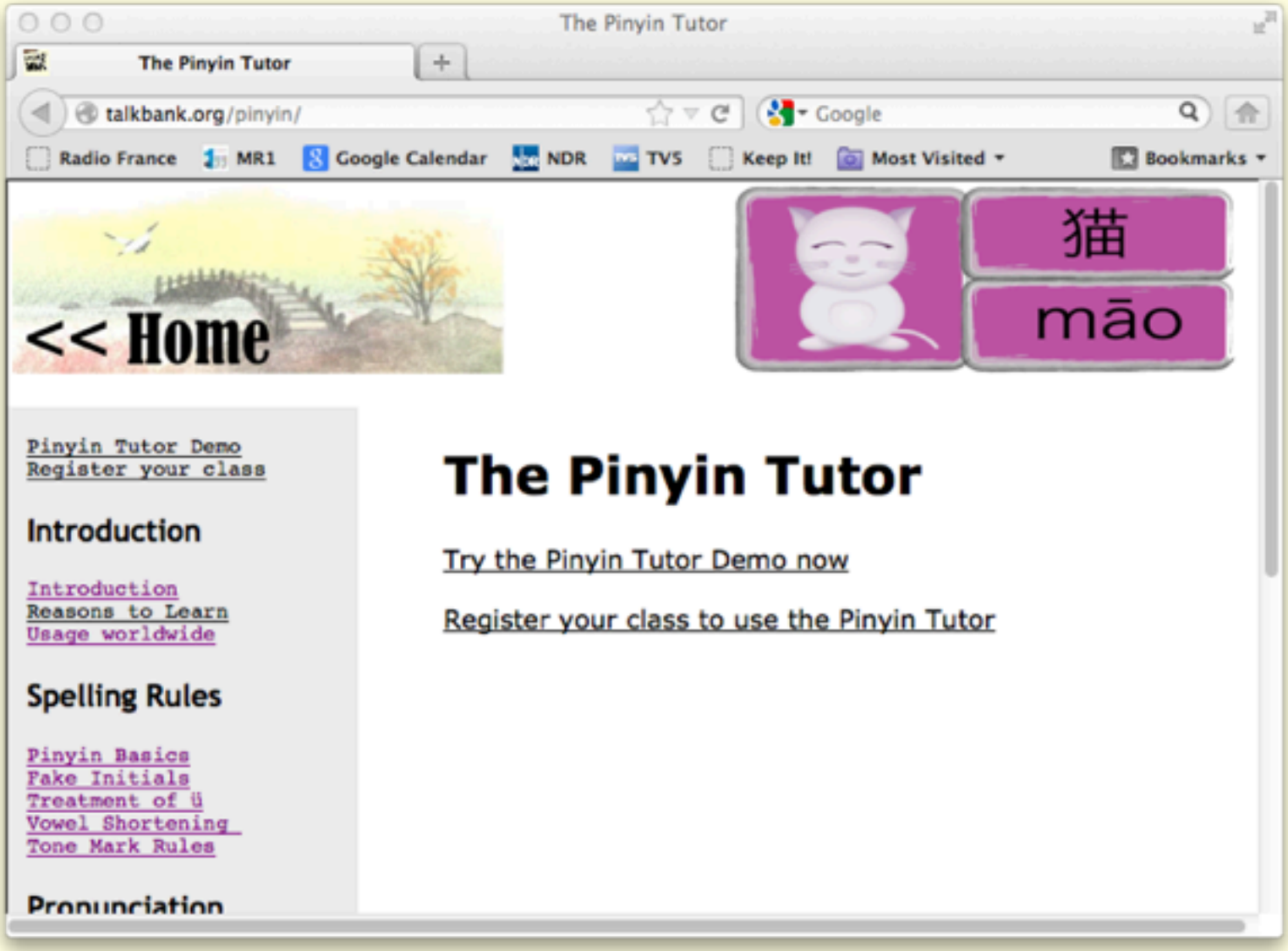
Helen Zhao: English article tutor

Yueran Yuan: preposition games

Like Li: character tutor

Dan Walter: German case/gender cues

talkbank.org/pinyin - Yanhui Zhang



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

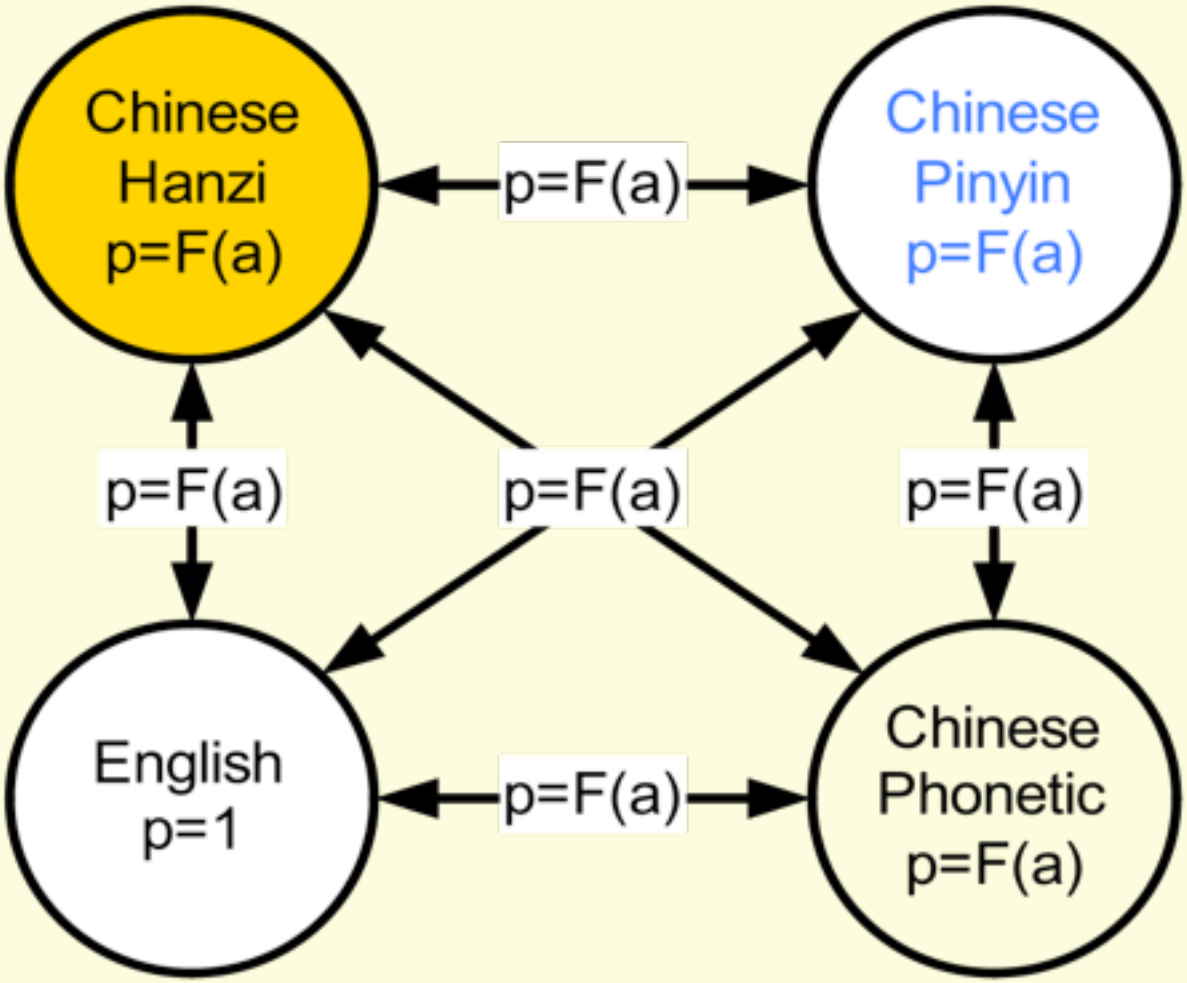
Spy Game - Yueran Yuan

Vocabulary and Resonance

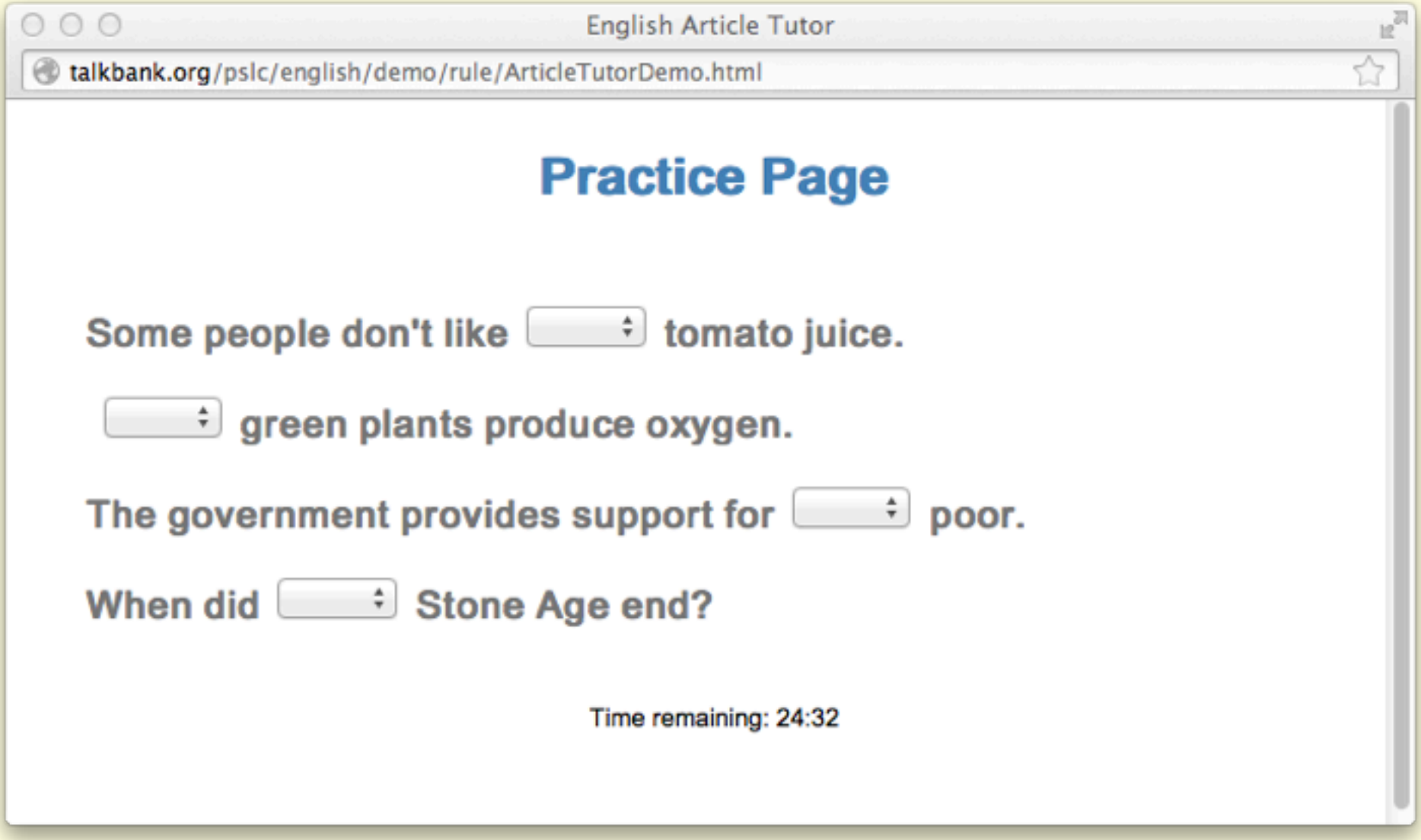
Interactive Activation and Gangs

Units that fire together, wire together

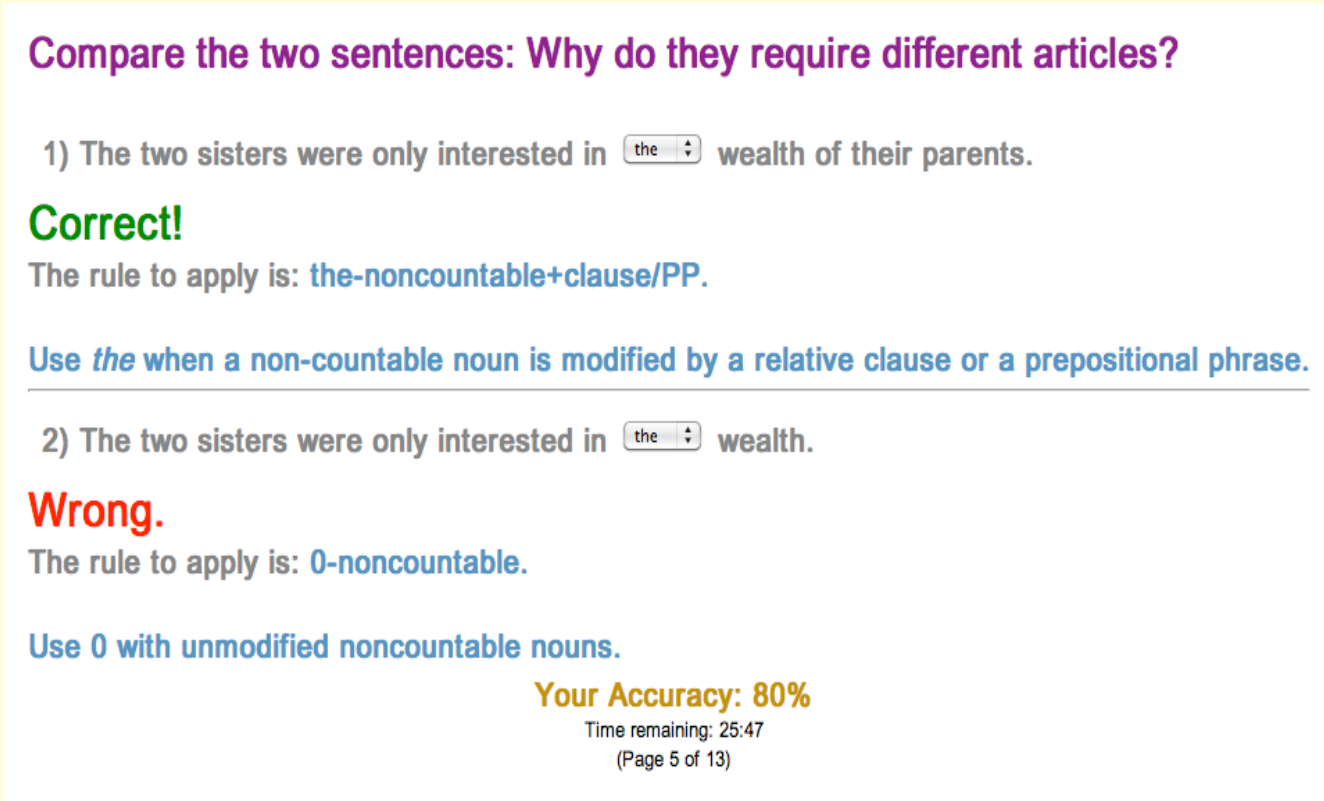
Resonance and Representations



English Article Tutor–Helen Zhao

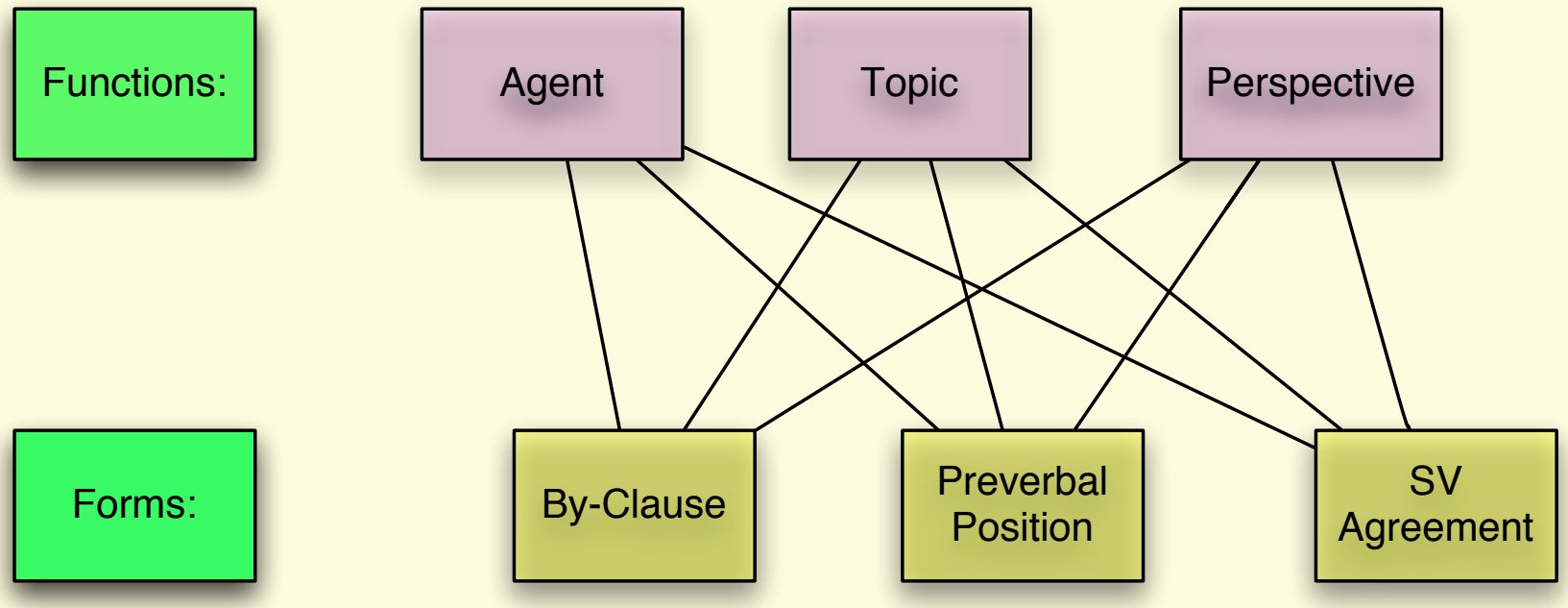


Minimal Pairs with Rules vs Examples



Competition Model – Cues

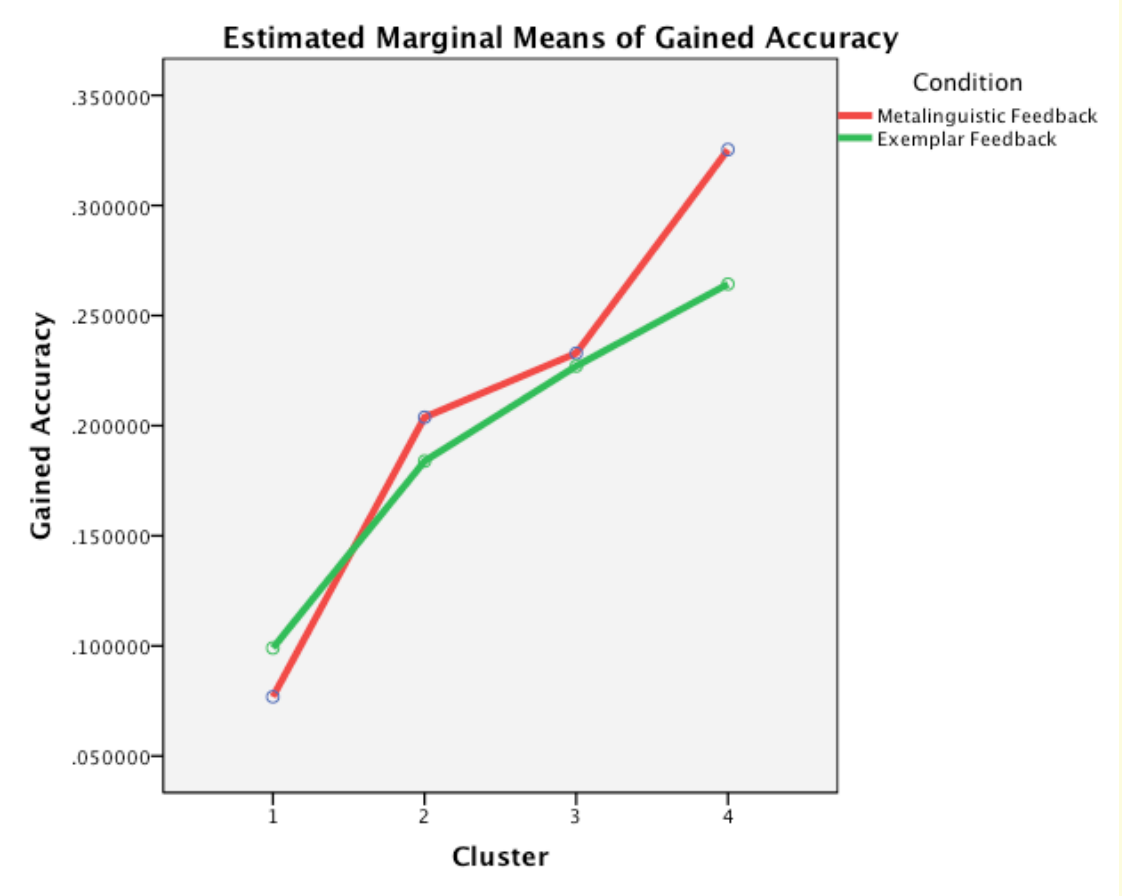
- Functions compete for forms
- Forms compete for functions



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)

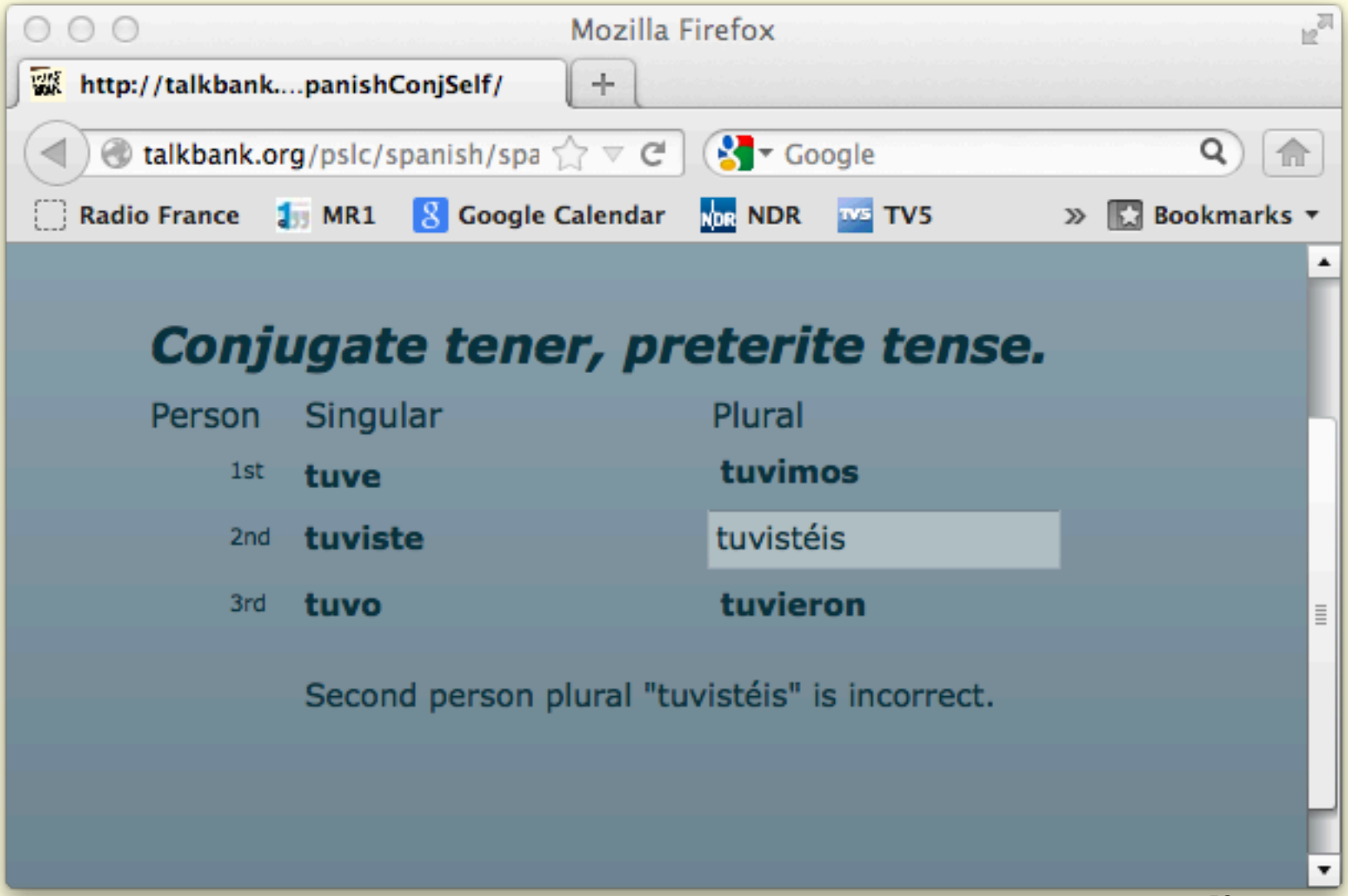
Greatest gains for explicit feedback with transparent cues



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.

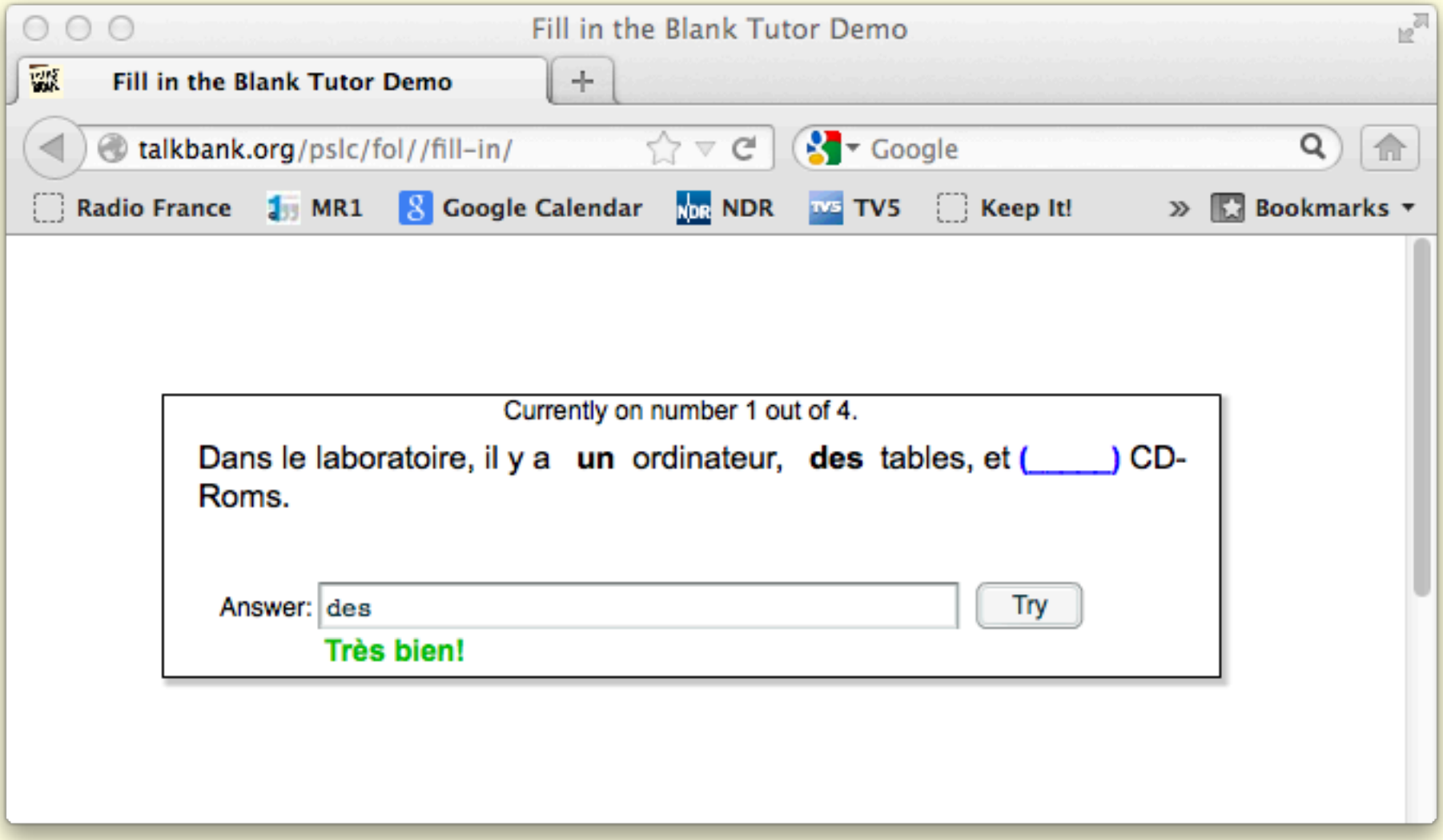
Spanish Conjugation
Presson, MacWhinney, Sagarra



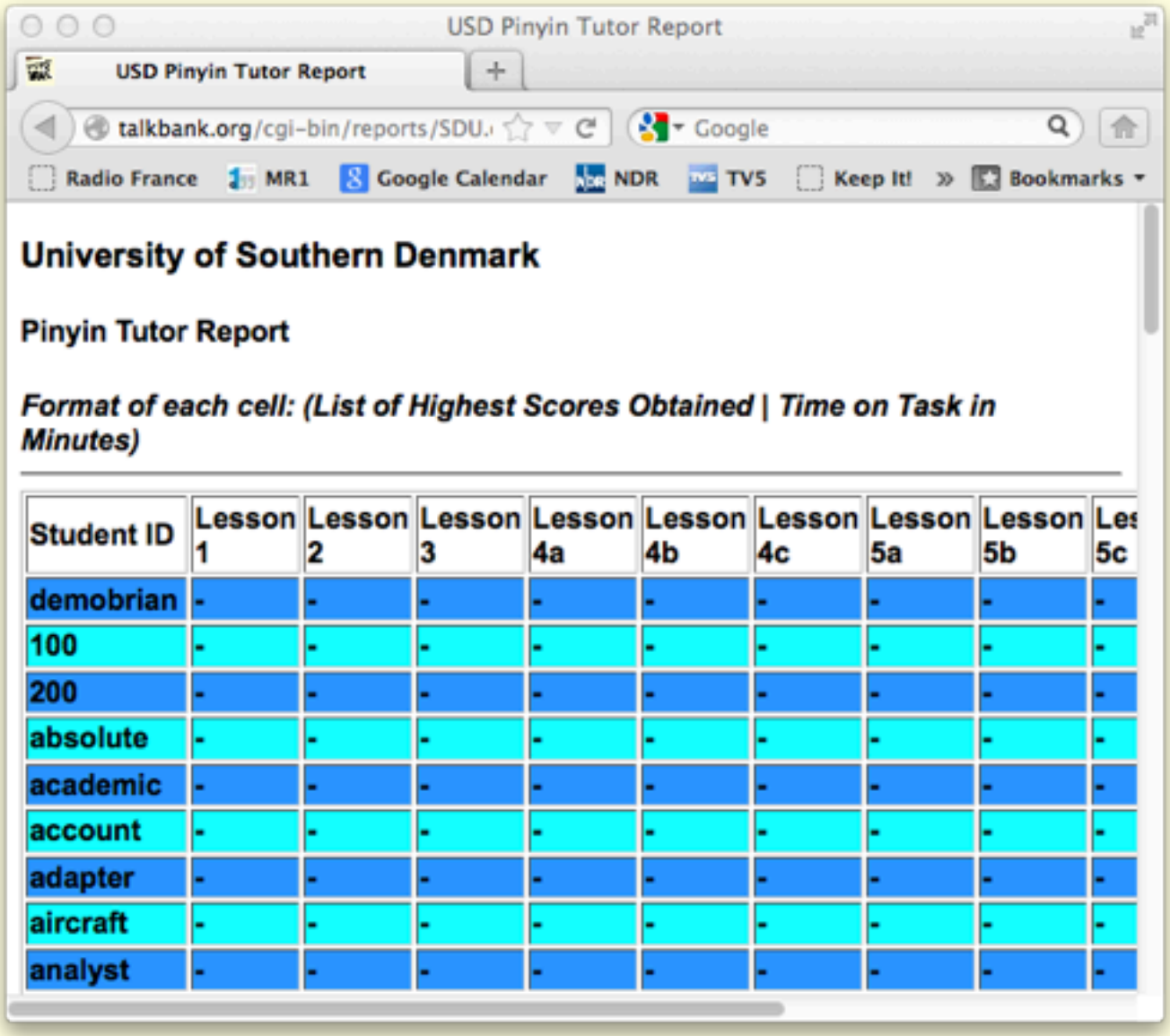
Cues

- 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



Reports to Instructors

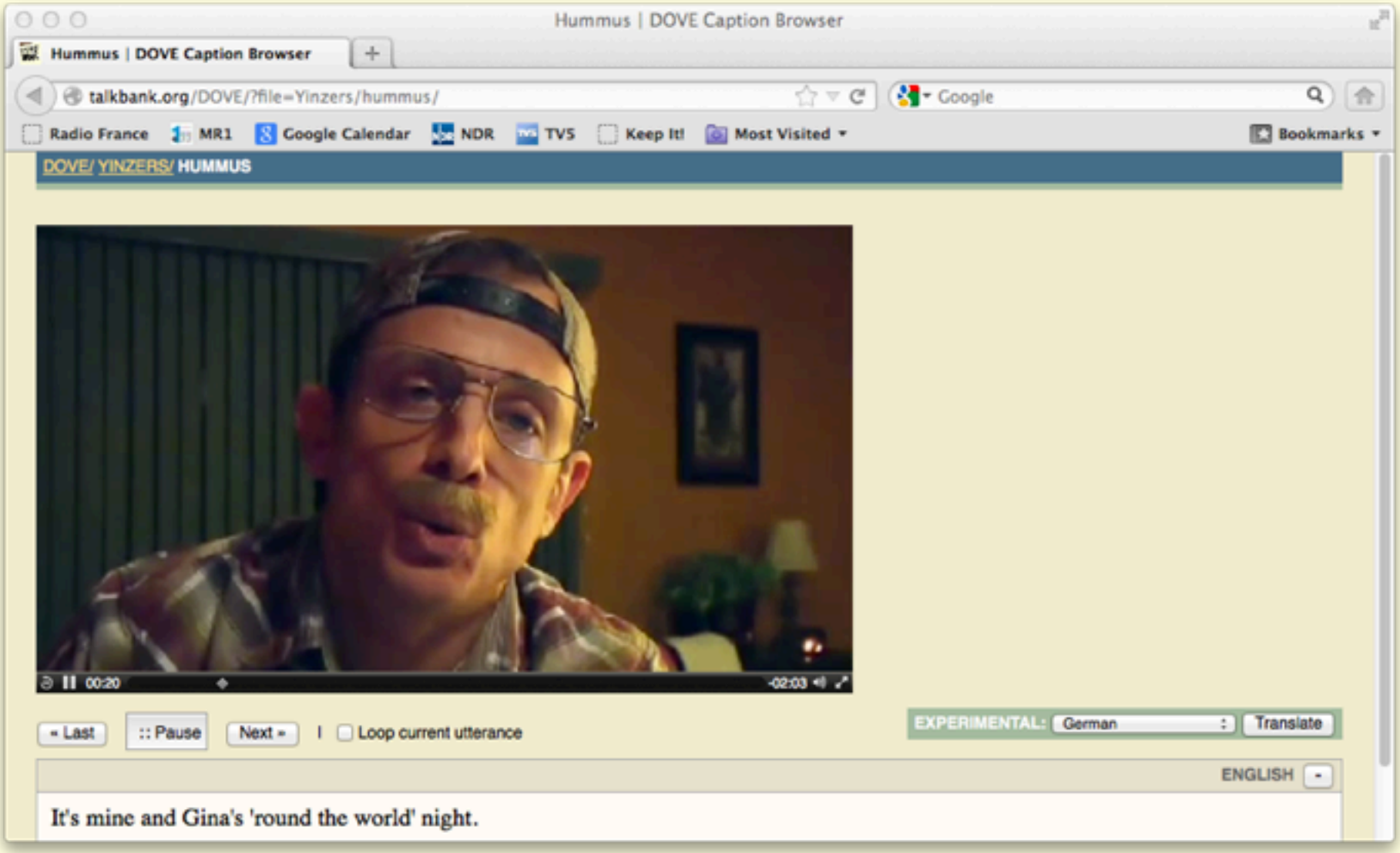


Student ID	Lesson 1	Lesson 2	Lesson 3	Lesson 4a	Lesson 4b	Lesson 4c	Lesson 5a	Lesson 5b	Les 5c
demobrian	-	-	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-	-
200	-	-	-	-	-	-	-	-	-
absolute	-	-	-	-	-	-	-	-	-
academic	-	-	-	-	-	-	-	-	-
account	-	-	-	-	-	-	-	-	-
adapter	-	-	-	-	-	-	-	-	-
aircraft	-	-	-	-	-	-	-	-	-
analyst	-	-	-	-	-	-	-	-	-

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)

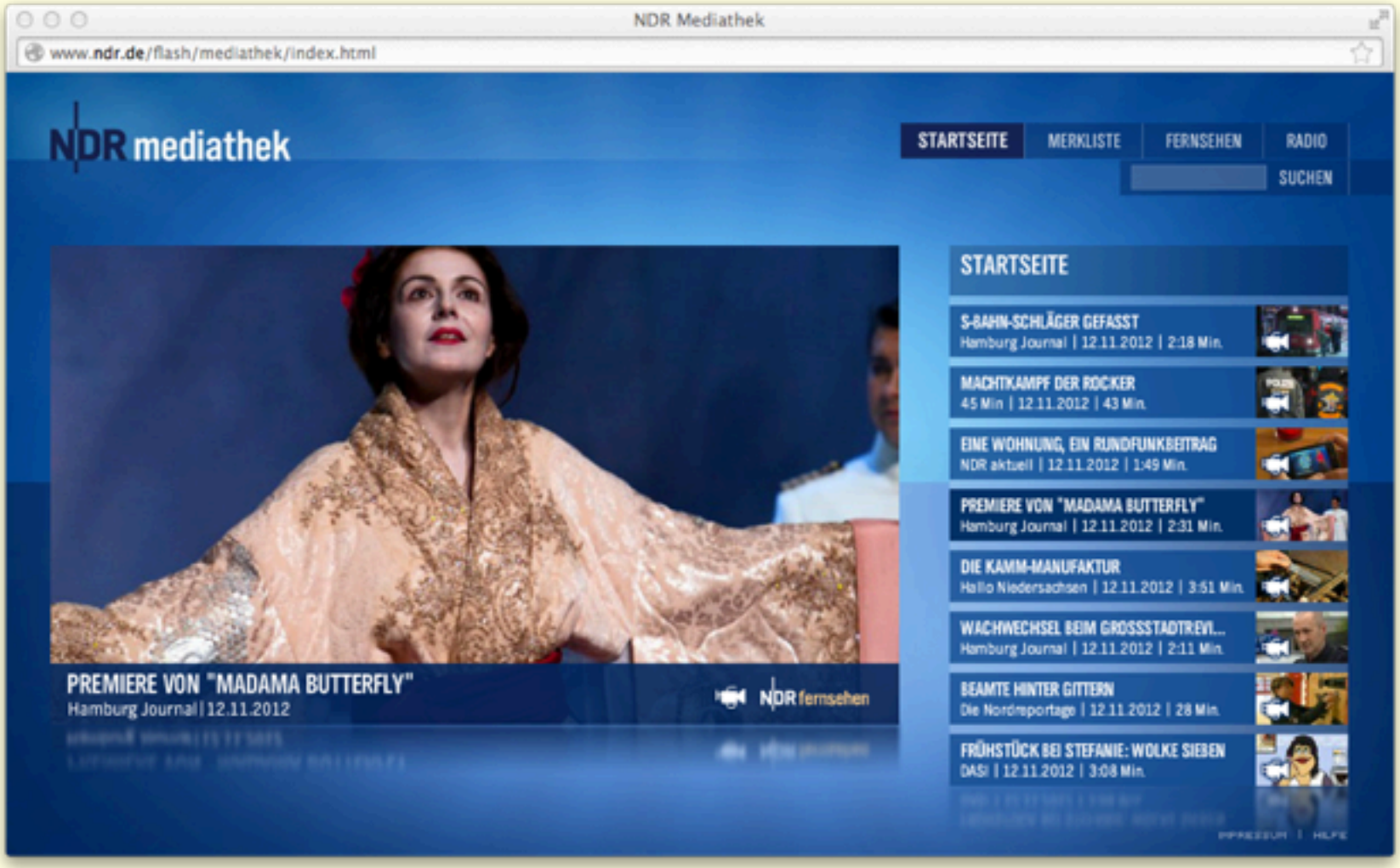
DOVE Subtitled Video



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

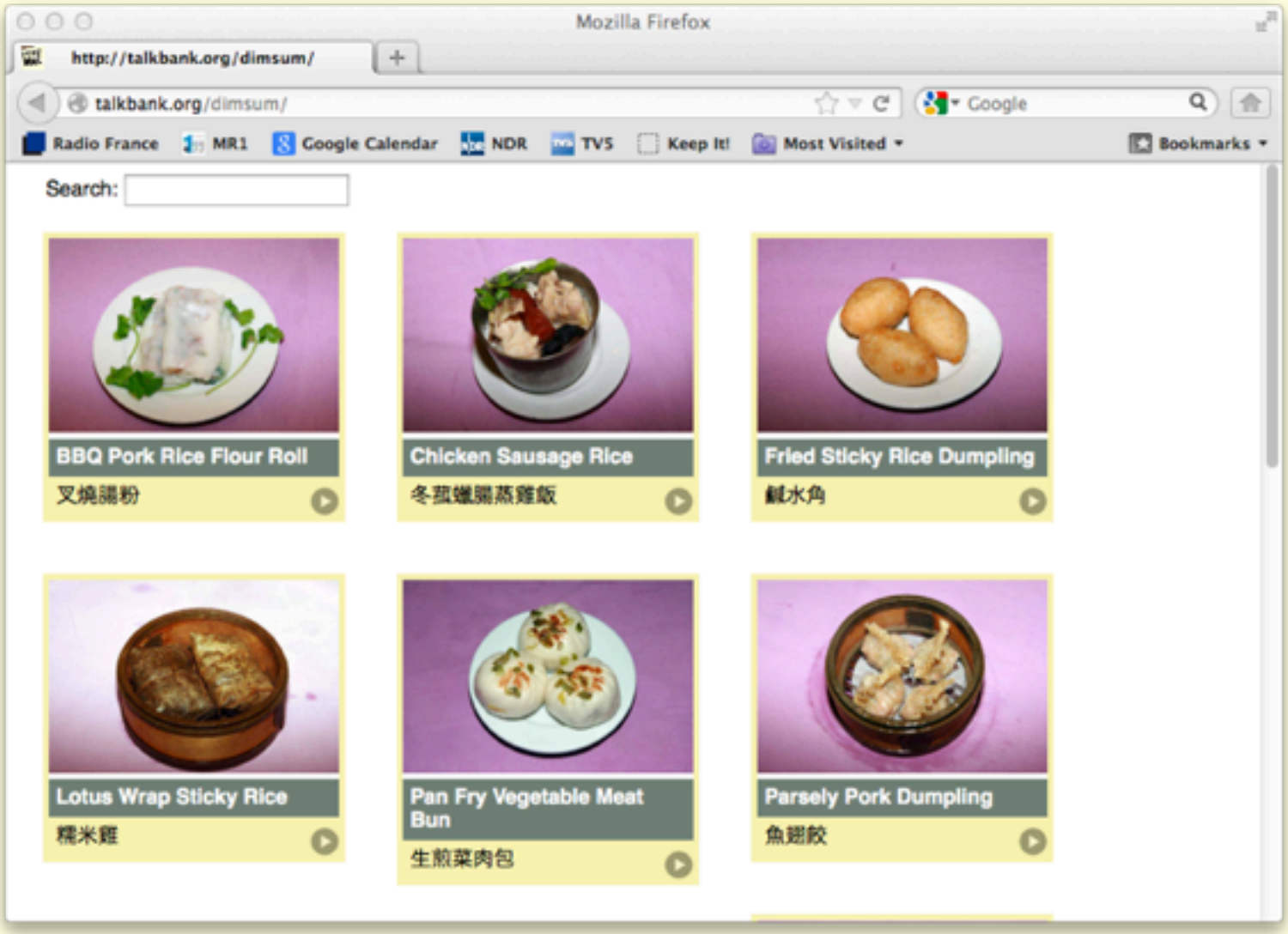


iPad extensions

- 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

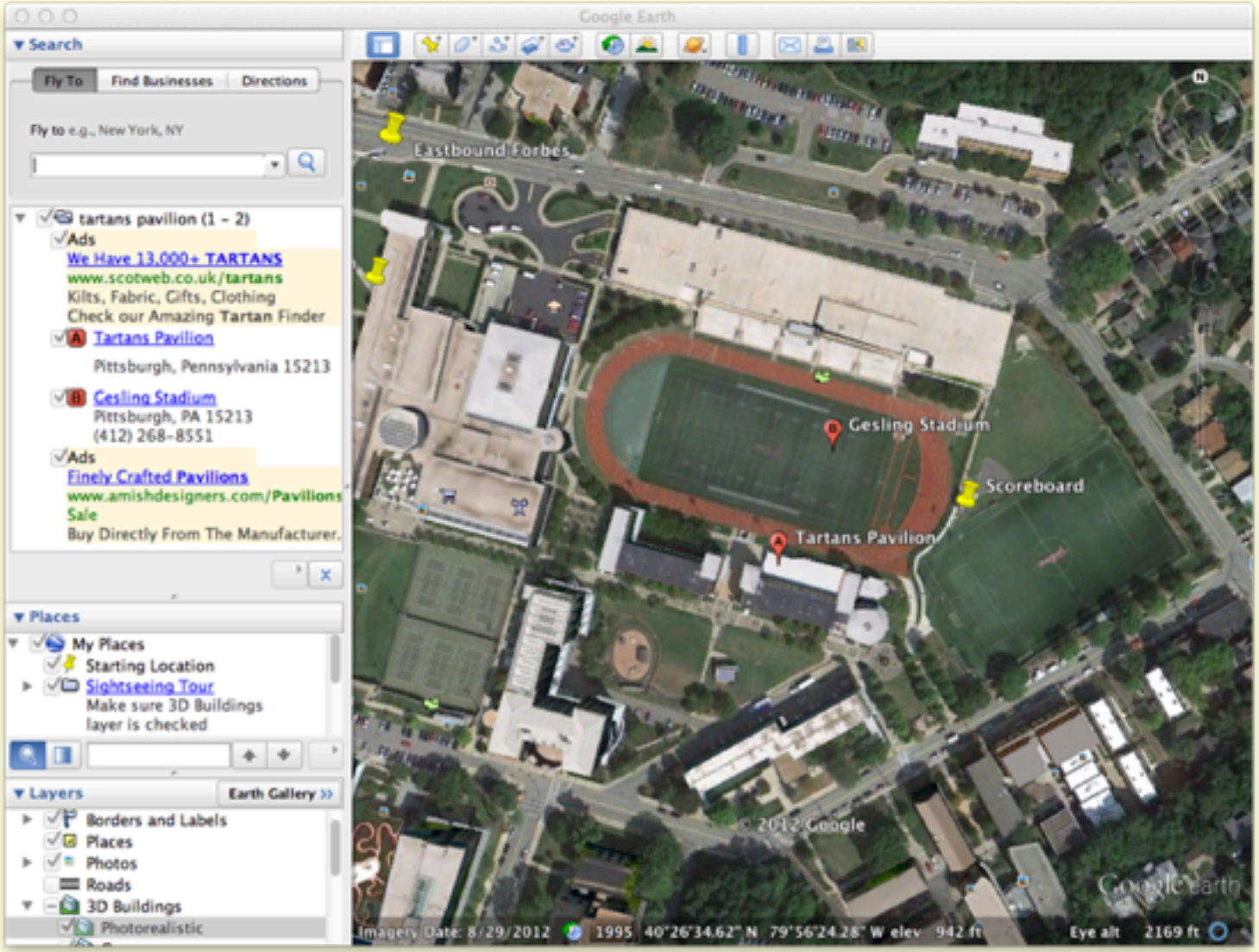
talkbank.org/dimsum



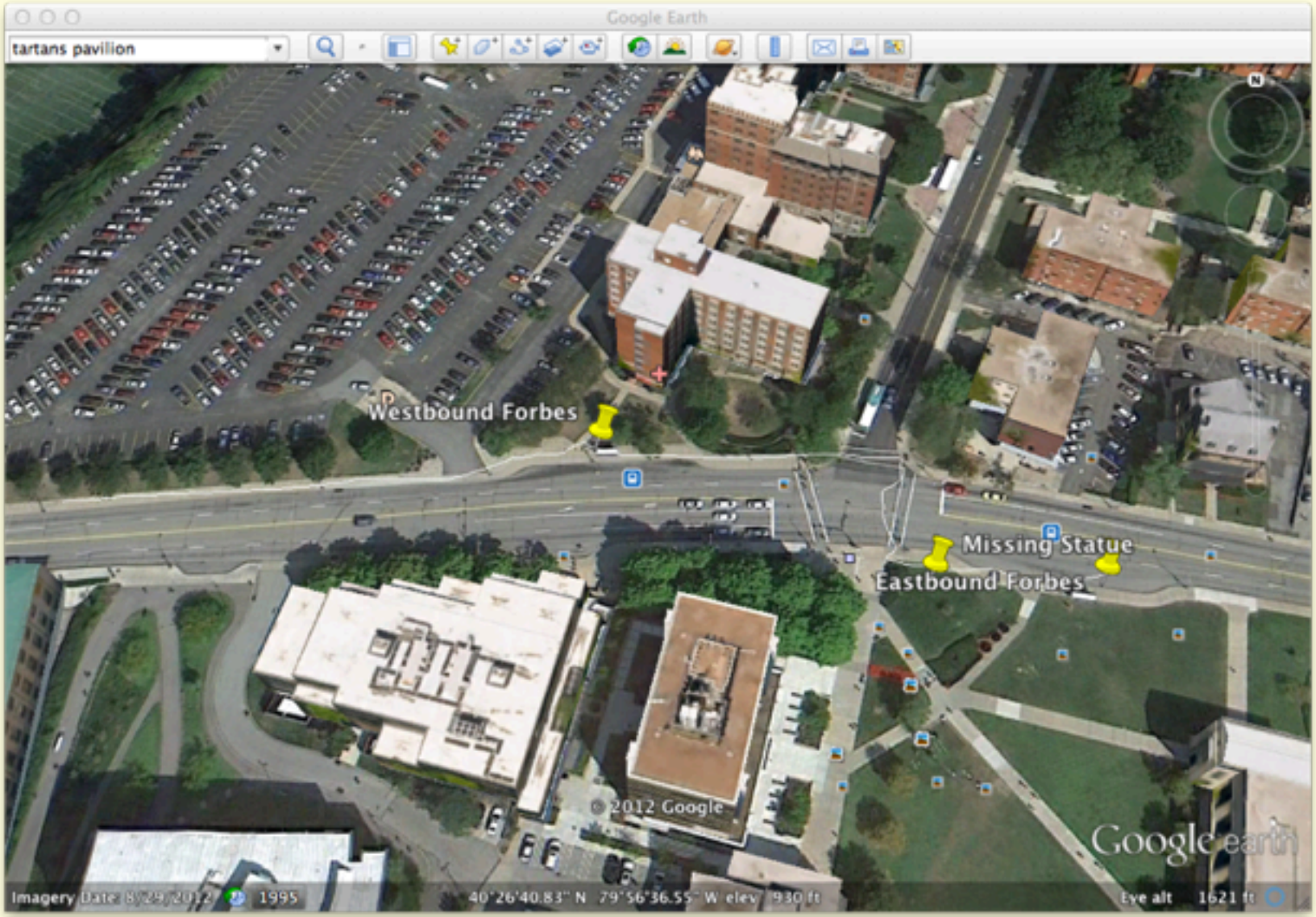
Embedded (situated) communication

- 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

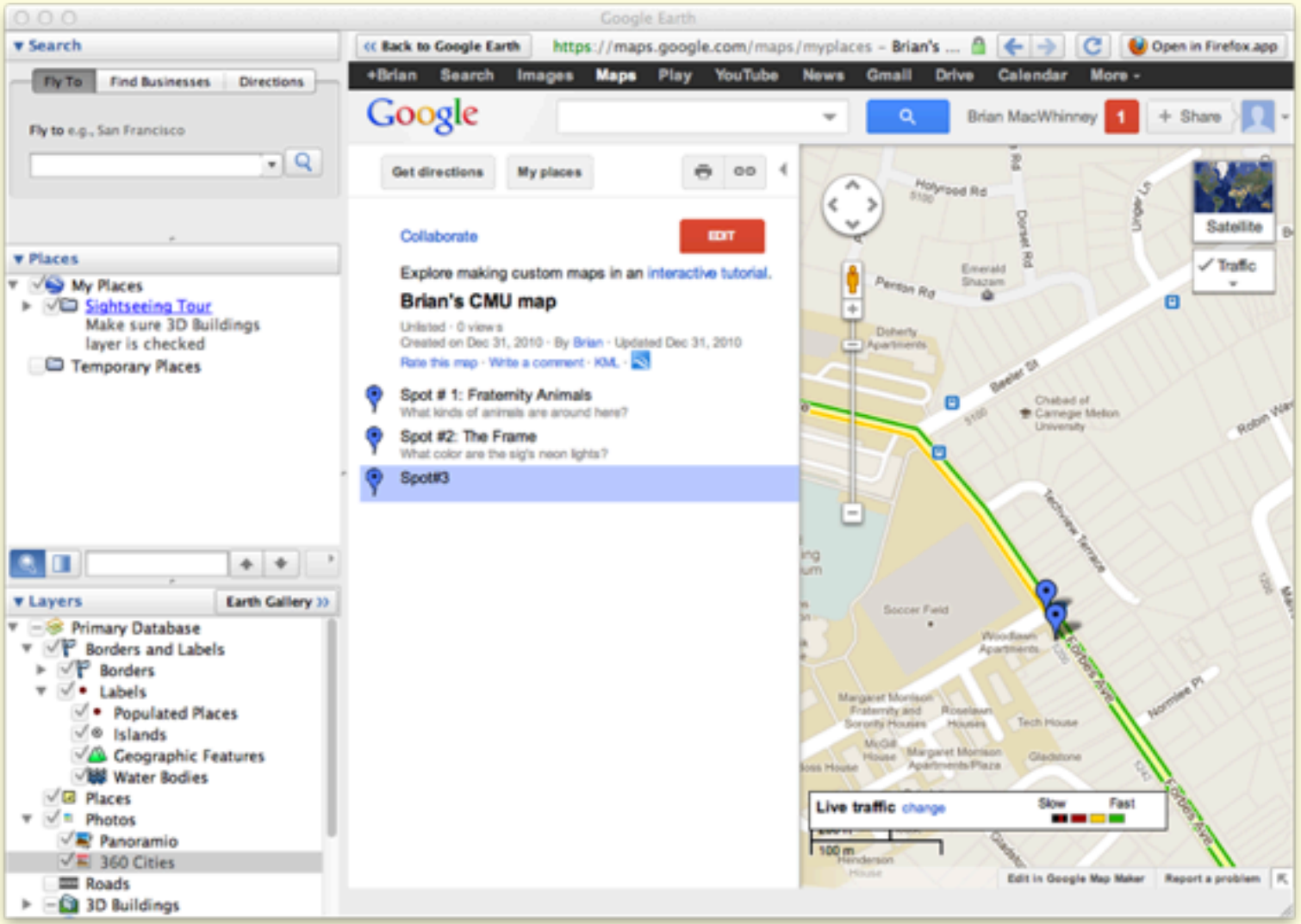
Google Earth Tours



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

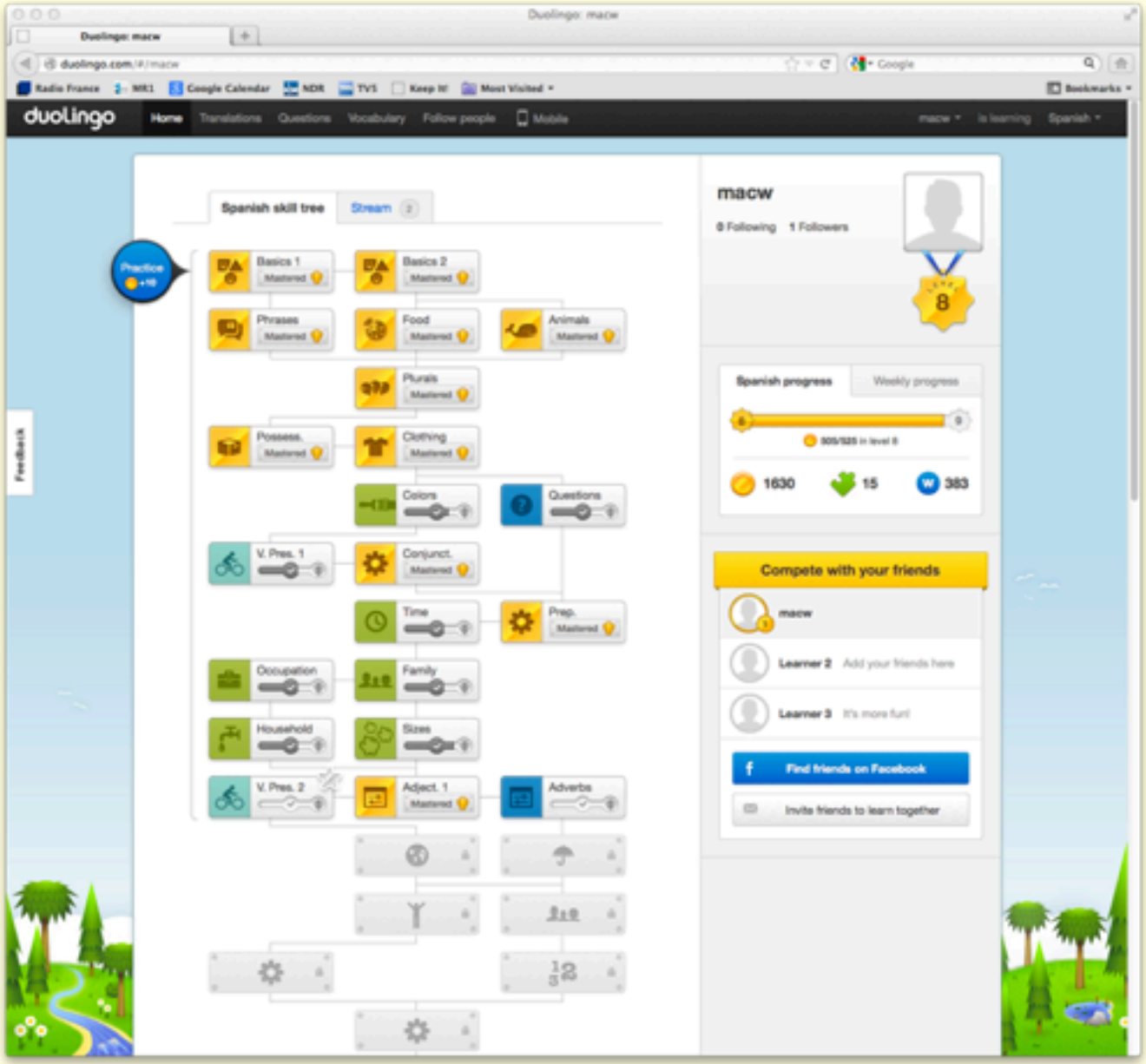
- We will not know based only on laboratory experiments.
- We must have longitudinal data.
- With opportunities for learners to select alternative support methods.

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
Home
Translations
Questions
Vocabulary
Follow people
Mobile
Spanish skill tree
Stream
Practice
Basics 1
Basics 2
Phrases
Food
Animals
Plurals
Possess.
Clothing
Colors
Questions
V. Pres. 1
Conjunct.
Time
Prep.
Occupation
Family
Household
Sizes
V. Pres. 2
Adject. 1
Adverbs
macw
0 Following 1 Followers
Spanish progress
Weekly progress
1630
15
383
Compete with your friends
macw
Learner 2
Add your friends here
Learner 3
It's more fun!
Find friends on Facebook
Invite friends to learn together
Feedback

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 → L2, L2 → 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

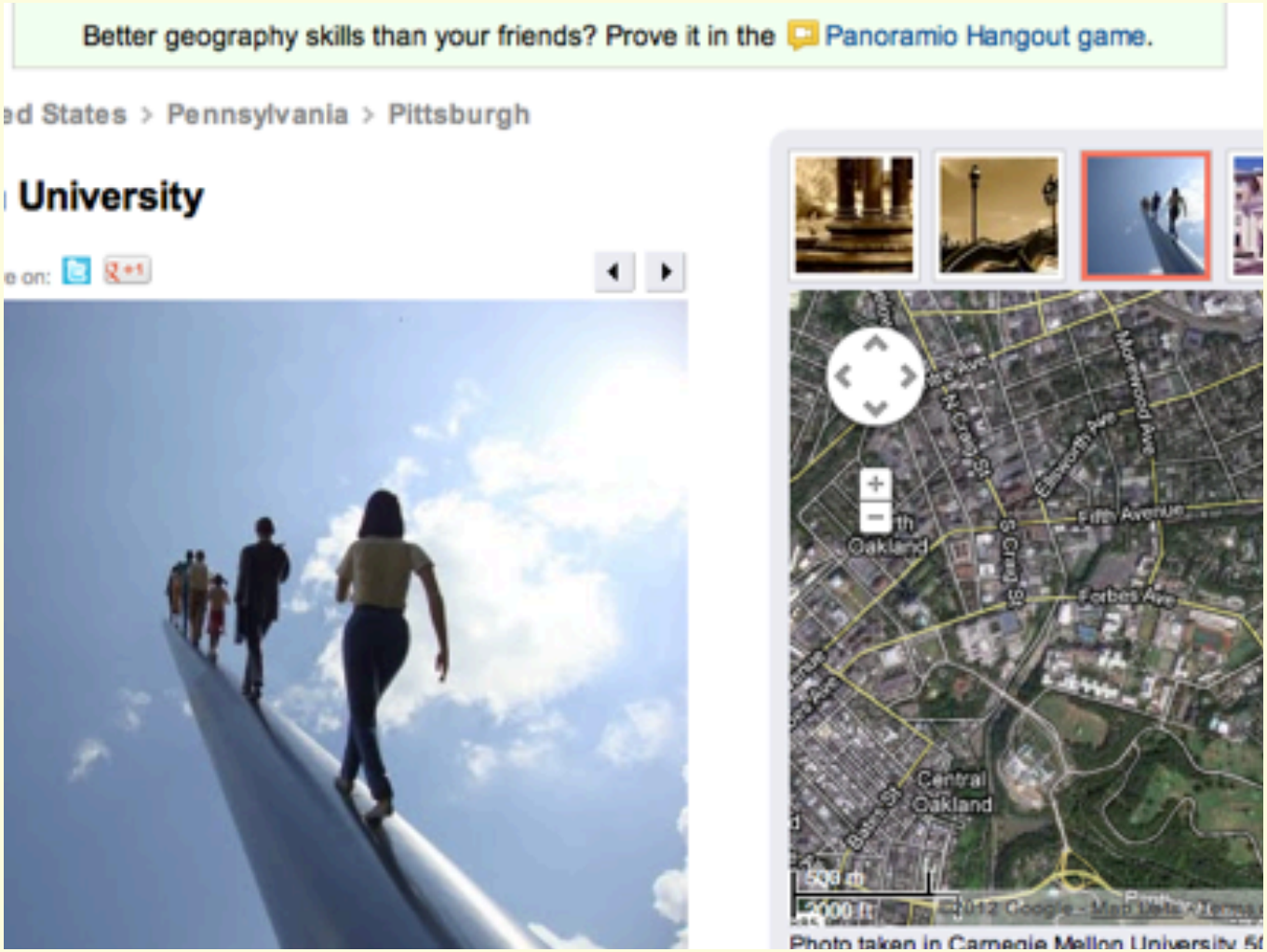
Traditional SLA Research

- 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