Crosslinguistic Study in Protracted Phonological Development

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Purposes

- to compare children's phonological patterns across languages that are both similar and different in terms of word structure, stress, segmental inventories and relative complexity
- To discover to what extent patterns observed reflect universal versus language- or child-specific constraints
- To determine what protracted development might mean to different language and cultural groups
- To develop some clinical tools for elicitation and analysis available free, PHONBANK

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Protracted Phonological Development

- Search for a neutral term.....
  - people whose phonological development is 'stretched out' in time relative to what's often expected
  - Neutral with respect to etiology
    - not necessarily "disorder" or "delay"
  - Inclusive positive focus
    - highlights strengths & needs in the system
    - acknowledges family/society's feelings of negativity relative to words such as 'disorder', 'impairment'

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Outline for today's talk

- Overview of the project
- Preliminary data from Manitoba French, Slovene, Spanish, Mandarin, German, English
- Computer programs and phonological analysis
  - Speech.App (NeXt), 1994-2003 (research)
  - Computerized Articulation and Phonology Evaluation System (CAPES, Masterson & Bernhardt), 2001-present, soon to be freeware (clinical purposes + research, any language)
  - Phon

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Criteria for language selection

- Someone in Vancouver area is a native speaker or fluent second language speaker of that language and is trained in phonetics and phonology (linguistics, speech-language pathology) and we have been able to find partners in other countries
- Variety of language families
- What else would we like? Canadian Aboriginal languages

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How many participants?

- 30 preschoolers per language with protracted phonological development
- If possible, a matched typically developing sample (only possible where within-country funds permit)
- People with protracted development allow more time to observe phenomena
- Adult speaker(s) of the dialect area

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Which languages so far

- Germanic: English, German, Icelandic, (Swedish?)
- Romance: Spanish (Andalucía, Latin America), Canadian French (Manitoba), (French of northern France?)
- Semitic: Kuwaiti Arabic
- Finno-Ugric: Hungarian
- Asian: Mandarin (Shanghai, Taiwan), Japanese
- South Slavic: Slovenian, Bulgarian

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Collaboration sites

Europe: U. of Cologne, U. of Granada, U. of Ljubljana, The National Hearing and Speech Institute of Iceland, Rejkjavik, University of Western Hungary, (U. of Linköping, U. of Paris, U. of Bulgaria)

Middle East: Kuwait University

Asia: Shanghai Children's Medical Centre, National Chiao-Tung University, (Osaka University)

North America: Vancouver Coastal Health (Spanish, Mandarin, Japanese), Division Scolaire Franco-Manitobaine (DSFM): Manitoba, Canada

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Language	Word list	Recorded	Transcribed	Analysed
English	PAT 1997	30	30 PPD	Most (quant)
German	NILPOD	50	20 each, TD, PPD	50% (quant)
Slovene	Project list	57	2 PPD	2 (scan)
Mandarin	Project list	67	31 (29 Typical)	20% (quant)
Icelandic	Project list	19	2, first pass PPD	2 (scan)
Spanish	Project list	5	2	2 (scan)
French (Can)	Project list	3	2	1 (quant)
Kuwaiti Arabic	Project list	80	80 TD	50% (quant)
Japanese	Project list	2010 summer		
Others	In the wings.....	2011		

Testing

- Single word (primary) and connected speech data (for purposes of informal language evaluation and possible intelligibility evaluation later)
- Language comprehension test if available
- Hearing screening if available
- Brief oral mechanism examination
- Digital audio recording (some also have video) with high quality microphones in quiet environment (school, preschool, home, clinic)

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Single word list elicitation

- Efficiency and content coverage
- 80-110 words which sample a variety of
  - word lengths, stress patterns, word shapes
  - and elicit segments across word positions
    - never less than two tokens per segment category
- Selected with the first-language partners
- Words that are imageable and at least somewhat familiar to most preschoolers
- Free stock photos, organized in themes (loose narrative)
- Repetition of 10 words with object elicitation for within-word variability measure

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Transcription

- 1 or 2 native speakers transcribe 1-2 initial data sets.
- Use of wave/spectrum analysis program to verify voicing, frication, glottal stops, etc.
- The team works collaboratively to decide on conventions for transcription for that language, trying to maintain equivalent levels of narrowness across languages and account for what is possible to agree on, and what not, for that language
- A transcription conventions document is then available for each transcriber outlining the key elements for transcription
- 1 main first language transcriber, with reliability by a second (10% of sample unless more funds permit more)

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Analyses

Quantitative: Overall plus specific topics

- Computerized Articulation and Phonology Evaluation System (Masterson & Bernhardt, 2001), soon to be available as FREEWARE via authors.
- Excel analyses: Spreadsheet analyses to compare patterns across languages (e.g. confusion matrices)
- PHON: Very Near Future

- Qualitative (linguistic)

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Analyses for clinical purposes

Nonlinear scan analysis using form/process similar to Bernhardt & Stemberger, 2000 (Workbook in Nonlinear Phonology for Clinical Application, Pro-Ed) for English

- Now available free for Spanish, Mandarin, Icelandic from investigators (in the language or in English)
- Will be available through publication for German (Angela Ullrich: NILPOD, probably 2011/2012)
- End of 2010, for French, Japanese, Slovenian

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Preliminary data, questions

- Manitoba French
- Spanish (Argentina, Mexico)
- Slovene
- Mandarin
- German vs English

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Preliminary Data, Manitoba French

1 child, age 4, PPD

- **Segments:** Mismatches on sibilants, grooving, voicing of stops and fricatives (similar to English)
- **Structure: Word length relevant**
  - Disyllabic words (iambic) 92% match (stress, length)
  - Multisyllabic words: 52% accuracy for syllable maintenance (some deletion of weak syllables) and transposition or other mismatches affecting segments.

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Segment-structure interactions

Nasal vowels: Vary with word length, stress

- 80% match in *stressed* syllable position **BUT** 35% match in *unstressed* syllable position
- 75% match *in 1-2 syllable words* **BUT** 43% match *in multisyllabic words*

Clusters: Reduction reflects position

- 72-79% match for number of Cs (CC) in syllable-initial and word-final positions **BUT** 10% CC use across syllable boundaries (e.g. trac.teur):

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Ongoing questions.....French

- Segmental matches and patterns?
- Interactions of stress and word length with segmental accuracy (both Cs and nasal Vs)?
- Multisyllabic word patterns

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Preliminary data, Spanish

- Two boys, 4;9, living in Vancouver area (plus dialect data from their parents, Buenos Aires, Mexico City)
- RP1 primarily Spanish, RP2 both languages but Spanish at home exclusively, English in the community
- No other developmental concerns reported (including sentence production)

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Similarities: Prosodic Structure Mismatches

- No word-initial CC, but a few word medially
  /triˈaŋgulo/ [aŋgulo] (RP2)
- Word-initial Cs affected in initial weak syllables
  Deletion: /saˈpatos/ [eˈhatos] (RP2)
  Glottal use: /toˈkando/ [ʔaˈkano] (RP1)
  Harmony (redup): /saˈpatos/ [paˈpatos] (RP1)
- Reduction or alteration of VV sequences
  /ˈgracias/ [ˈhatas] (RP2)
  /ˈʃueβe/ [ˈʃoːwe] (RP1)

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Differences: Prosodic Mismatches

RP1

- Deletion of weak initial syllables with [eh]:
  /~~eh~~kuela/ [ˈxuera]
- Deletion of initial stop following article 'el':
  /el ˈbaŋo/ [el ˈaŋo]
- Consonant epenthesis in vowel sequence:
  /ˈdi.a/ > [ˈdi̪di̪a] (día)

RP2

- Stress shift: Sw to wS with strengthening of consonants between Vs
  /ˈuβas/ [uˈbas]
- Timing units maintained with a 'glide-like element" or with consonant lengthening word medially

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Differences: Consonant mismatches

RP1

- tʃ > ʃ
  /notʃe/ [noʃe]
- r, ɾ > l, ɾⁿ, ɾˡ, ʔ, x
  /giˈtara/ [ʔaˈtaɾˡa]
  /ˈ**kaɾa**/ [ˈ**tal**a]
  /kuˈtʃa**ɾa**/ [kuˈʃada]
  /reˈlox/ [ʔaˈlox]
  /raˈton/ [x̌aˈton]

RP2

- WI Cs > [h]
  /pes/ [hes]
  /eleˈfante/ [eˈhante]
- Onset /l/: [h], deleted or word medially, 'glide'
- Onset /r/, tap: Deleted, or word medially, [g] or 'glide'
- ¡WF /r/, /l/ > [t] sometimes
  /flor/ [hot]
  /aˈsul/ [aˈsut]

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Sequences: RP1 (RP2 also)

Many sequence difficulties (place/manner)

- elefante: [elaˈfaːfe] (harmony-redup.)*
- globo: [ˈwowo] (harmony-redup.)
- zapatos: [pʰaˈpatos] (harmony-redup.)
- nariz: [aˈnis] (deletion, metathesis)
- blanco: [ˈlakõ] (deletion, migration)
- lámpara [ˈmakala] (metathesis, [k] medial)

◦ *Where reduplication is either partial or full.

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Ongoing questions: Spanish

- Mismatch patterns for (light) /l/ and trilled /r/:
  - [l] for /r/, glide-like elements, nasalized or lateralized taps
  - Similar glide-like segments in Slovene, Zapotec
- Deletion of initial stop following the masculine article 'el' (baɲo > aɲo)
  - NOTE: also noted for one of our French pilot subjects - /l/ of 'le' took precedent over the initial stop.....
- Sequence difficulties: CC, C_C, VV?
- Initial Cs in initial weak syllables?

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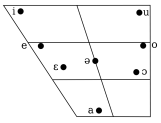
Slovene: Segmental Inventory

Consonants

Slovene has 21 distinctive consonant phonemes. Conditional allophones are shown in parentheses.

Slovenian consonants[4]

	Bilabial	Labio-dental	Dental	Palato-alveolar	Palatal	Velar
Nasal	m		n			(ŋ)
Plosive	p b		t d			k g
Affricate			t͡s (d͡z)	t͡ʃ d͡ʒ		
Fricative		f	s z	ʃ ʒ		x (ɣ)
Approximant		ʋ	l		j	
Trill			r			



Some stressed Vs long,
others short.
Unstressed short.

Preliminary data: 2 children with PPD

- Boy, age 4;7, Whole Word Match 44.6%
- Girl, age 4;9, Whole Word Match: 43.6%
- Same dialect spoken by both children, & parents

Similarities: Prosodic Structure Mismatches

- Some mismatches in initial unstressed syllables, especially wwSw and wSww
  - deletion, cluster reduction, features
- Mismatches with specific cluster types (with /r, n/)
- A few words with stress shift
  - Sw to wS, but also wS to Sw; /baˈlo:n/ [ˈba:lonˑ]

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Similarities: Segmental Patterns

- Liquids
  - /l/ -- mostly matches
  - /r/ restricted, with errors including [l]
    - (cf. Kocjančič, 2004)
    - Boy had more taps
    - Girl had more different substitutions
- Velars almost always match target (for place)

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Similarities: Segmental Patterns

- Some aspiration of voiceless stops, e.g. /k/
  - /ʃpaˈge:ti/ [ʃpʰɑˑˈge:tʰɪ]
  - including word-final "b,d,g" (devoiced but unaspirated in adult speech)
    - /gump/ [kʰumˑpʰ]
- Some devoicing of /b,d,g/ (onsets)
- Some /e/-/ɛ/, /o/-/ɔ/ confusions, vowel duration issues

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Differences: Segmental Patterns

Boy

- Alveolopalatals ɕ, ʑ
  - /sɔ:k/ [ɕɔᵊkʰ]
  - /ʒɑ:bɑ/ [ˈʑa:bạa]
- Harmony
  - /ˈsɔntsɛ/ [ˈɛtɕɔntɕɛ]

Girl

- Initial /g,z,ʒ,v/
  - epen. sonorant (C, V)
    - /grɑ:t/ [ŋgla:tʰ]
    - /glɑ:vɑ/ [ᵊglavɑ]
    - /ˈzaitərk/ [ʔəˈzaitʌ[kx]
    - /vo:s/ [ᵘvo:s]
- Harmony, velar fric.
  - /xɛliˈkoptər/ [xɛ.iˈxoptəl]
- Affricates in clusters
  - /ˈʃkɑ:rjɛ/ [ˈtʃka:jɛ]
  - /ˈʃtʃe:tkɑ/ [ˈtʃetkʰɑ]

/r/, Boy

- usually [l,ʁ]
  - word-initial — in wwSw
    - /ruˈmɛn/ [ʁo̯ˈmɛn̪] /vɛvɛˈritsɑ/ [vɛ:vɛˈlitˈsɑ
- /r/: tap [ɾ]
  - between Vs — in initial Cr
    - /dɑˈri:lɔ/ [dɑˈri:lɔʰ] /ˈxru:ʃkɑ/ [ˈkʰru:s:kʰɑʰ]
  - word-final /ˈti:gər/ [ˈti:gəɾ̪]
- deletion: /r/ or C, or epenthesize V in /rC/
  - /ərˈde:tʃ/ [ʔaˈd:etʃ] /ˈtʃərn/ [ˈtʃə:rạ]
  - /ˈxərbɛt/ [ˈhə:rɛbɛtʰ]

/r/, Girl

- Substitutions of [l, ɭ, ɻ]
  - /tre:bux/ [tʰəˈle:bux] /ˈti:gər/ [ˈtʰi:gʌl̪]
    - incl. V epenthesis after [t, d]
  - /ərˈde:tʃ/ [əɻˈdetʃ]
- Tap [ɾ] uncommon (2Cr, 1VrjV)
  - /ˈʃkɑ:jɛ/ [ˈtʃka:jɛ] /ˈxru:ʃkɑ/ [ˈxru:ʃkʰ⁽ʰ⁾ɑ]
- Rarely deleted

Ongoing questions, Slovene

- Structural accuracy relatively high for codas, CC use in clusters and syllable maintenance in long words (reflecting language frequency)
- Relative accuracy for velars, /l/ segmentally?
- Types of mismatches?
- Interactions with adult variation
  - /e/-/ɛ/ and /o/-/ɔ/
  - /v/

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Mandarin Children with PPD

Gender	Age	Location	Whole Word Match
Female	4;1	Vancouver area	41/80
Male ("TD" cohort) S45	4;7	Shanghai	34/80*

Mean WWM for age 4: 66/80

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Similarities between the 2 children

Mismatch patterns:

- Inconsistency in use of target alveopalatals /tɕ/ and /ɕ/
- Vowel mismatches: more frequent, girl
- Some /ɻ/ > [l]
- De-retroflexion of retroflexed sibilants
  - possibly Shanghai Mandarin dialect

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Differences between the 2 children

Vancouver girl	Shanghai boy S45
Deterioration of vowels in connected speech	/l/ > [n], (/n/ > [l], [j])
Affricates > stops	Infrequent patterns:
Infrequent patterns:	Palatalization of coronal and dorsal Cs
Nasal coda deletion	Lateralized /ɕ/, /tɕ/
/l/ > [j]	/x/ > [f]

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Ongoing Analysis: Questions

- Tones: duration, sandhi, slope of pitch change
- To groove or not to groove? /s/, /ts/ vs /ɕ/,/tɕ/
- /ɻ/ not > [w] but > [l] or > [z]?
- /l/ not > [w] but > [j] or [n]?
- Vowel mismatches relatively more prevalent in Mandarin speakers with PPD and have a greater effect on intelligibility than for non-tonal languages?

& Dialects of Mandarin – Beijing/Shanghai/ Taiwan?

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German vs English: Participants

Language	# of boys	# of girls	Mean age in months
German	12	4	50.7 (SD 10.4) [+]
English	12	4	52.1 (SD 7.9)[+]

[+]p value: t-test .8023

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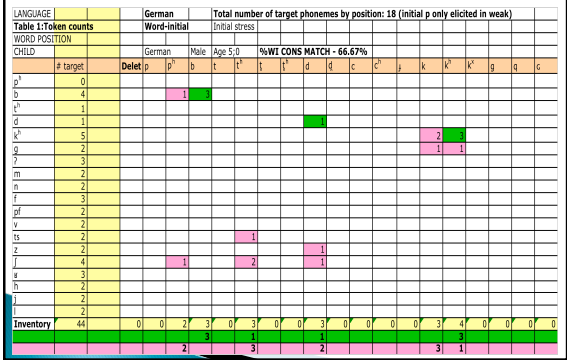
Extract from Confusion Matrix



Results: Overall comparison

Language	Mean Word Shape match	Mean Total C match	Mean Word-initial C match (with CC)
German	73.55% (SD 11.53)	63.89% (SD 10.59)	41.75% (SD 21.61)
English	39.2 % (SD 12.7)	40.03% (SD 9.4)	47.8% (SD 11.02)

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Word-initial singleton C in Sw: Mean match levels (accuracy)

Category	German	English
Stops and nasals	75.6%	70.8%
Fricatives, affricates	39.2%	27.4%
Glides, liquids and /h/	74.2%	60.8%
All single consonants	63.2%	54.1%
Cs in common (16)	67.8%	64.4%

Wilcoxon's for individual categories: Not significantly different
Student's t-test for total set: Not significantly different

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However: Liquids "l" and "r" Match proportions

Category	German	English
"l"	81.3%* (13/16 Ss)	22.6% (3/16 Ss)
"r"	43.8% (13/16 Ss)**	17.6% (3/16 Ss)***

*Proportion across participants
**Both /l/ and /ʁ/ for 3 Ss
***Both /l/ and /ɹ/ for only one S

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Substitutions for /l/ and 'r' by # of children

Some children had more than 1 substitution type

	German pattern	# Ss	English pattern	# Ss
l	h	2	w	9
	n	1	j	3
	c^h	1	v, d, ɲ, ʔ	1 each
"r"	Uvular fricative /ʁ/		/ɹ/	
	h	6	w	11
	χ	4		
	ɰ	3		
	ʁɰ, x, w, ɦ, deleted	1 each	[ʔ]/deleted	2

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Summary: Word-Initial Cs

Major SIMILARITIES

- Relative *% accuracy* for all but liquids
- % mismatch, place, ➔ manner equivalent

Similar patterns: Type/freq.

- Velar fronting %Ss
- Fricatives devoiced: %Ss

Major DIFFERENCES

- Accuracy for /l/ and rhotic higher in German
- *However:* Pattern differences
- More Ss stopping, English
- More [-voiced] > [+], English
- *Place substitutions (and to a certain extent, manner) reflect language's phonetic inventory, especially for fricatives, approximants*

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Ongoing Questions: German, English

- Differences in laryngeal patterns for stops are somewhat perplexing given the similar features in the two languages (although younger TD German children do have at least some de-aspiration of WI stops...Hoefflin & Stemberger, 2003). Acoustics?
- Word-medial and word-final position better in German than English for matched samples?

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Questions overall so far

- What is protracted development across languages?
- Severity : Equat-able across languages?
- Relative impact of segment types on inventory acquis.:
  - Light /l/ easier/acquired earlier than English /l/
  - Rhotics difficult yet the German variant earlier?
- Relative impact of inventory as options for substitution?
  - Palatals in German, liquid substitution types
- Relative match proportions, word structure?
  - e.g., Codas in English particularly challenging?
- Structural effects: e.g. Initial Cs and iambic stress?
- Article use and effects on initial C (Spanish, French)
- Sequence constraints across languages?

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Computer programs for phonological analysis

- NeXt-based Speech.app (virtually inaccessible due to dying hardware)
- ISPA-MAC (Masterson) (now out of date)
- Computerized Articulation and Phonology Evaluation System (Masterson & Bernhardt, 2001, soon to be copyright-returned)
- Uses and relative successes....

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Features	Program
Elicitation built in (photos/pix/video)	CAPES (mostly English)
Add unlimited new stored adult targets	PHON > Speech.App (CAPES)
Single wd, connected speech	PHON, CAPES, Speech.app
Audio/video in program, segmentation	PHON ☺
Inventory; match/mismatch analyses	CAPES, Speech.App, PHON
Word length, stress analysis	CAPES > PHON
Word shape analysis	**Speech.App >** CAPES
C, V level analysis	PHON> Speech.App > CAPES
Feature analysis (single, combo)	Speech.App, CAPES, PHON
Sequence analysis (CVC, CVCV)	CAPES > PHON
Queries for analysis	PHON ☺
Report output format: inventory and relational (accuracy), treatment sugges.	CAPES > PHON, Speech.Ap
Ongoing program revision	PHON ☺ (CAPES)
Available and free	PHON, CAPES (Speech.App)

USING PHON: Needs....

- Template for adult targets with easy way to link sound/video files - efficiency
- Word shape analyses: inventory, matches and mismatches
- Use of diacritics from Extended IPA
- Segment-structure interactions, sequences
- Upgraded report format

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- Need to seek ethics approvals from all countries to share transcriptions and where possible, audio
- Find a common format to submit the information

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See you in 2013 or 2014 in Vancouver for the Child Phonology Conference

And thanks, Yvan, for all this week and the excursion around the bay....

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