Conceptual Abstraction and the Embodied Mind:
The empirical study of spatial construals of time

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... at my hotel room in Tokyo ...

② 目覚まし時刻を見ながら、
▲UP（進む）▼DOWN（戻る）ボタンを押して時刻を合わせる。
(AM（午前）とPM（午後）を間違えないで下さい。)

Please “TIME ADJUST” buttons to set alarm time.
UP……Forward Time,
DOWN …Backward Time

① アラームスイッチを(OFF)にする。 赤色ランプ消灯
Turn alarm switch “OFF”.

② 目覚まし時刻を見ながら、
▲UP（進む）▼DOWN（戻る）ボタンを押して時刻を合わせる。
(AM（午前）とPM（午後）を間違えないで下さい。)

Please “TIME ADJUST” buttons to set alarm time.
UP……Forward Time,
DOWN …Backward Time

③ アラームスイッチを(ON)にする。 赤色ランプ点灯
目覚まし時刻表示の上に“0:00”が表示され、セット完了です。

Turn alarm switch “ON”.
The “0:00” sign will appear and the alarm lamp will shine red.

2 目覚ましアラーム鳴り止め

アラームスイッチを(OFF)にする。
赤ランプ及び“0:00”表示が消え、音が止まります。

Turn alarm switch “OFF” , “0:00” and lamp will disappear.

NOTE: If the time display is incorrect, please contact the front desk.
... some episodes in Homo Sapiens’ life ...
Contents

1. Everyday abstraction: Spatial construals of Time
   • Need of new classification systems: Ego- & Time-RP
2. Aymara: challenging some universals
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4. Exploring neural basis: an fMRI study (in progress)
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1. Everyday abstraction: Spatial construals of Time
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Spatial construals of Time

- Cognitive Linguistics
  - Waaaay *back* in the 50s …
  - The week *ahead* of us …
  - We are *coming* to the end of the quarter …
  - It is 20 minutes *ahead* of 1 o’clock
  - Halloween is almost *here*
  - Spring *follows* winter …

- … (and illustrations)
Spatial construals of Time

Impulso para o futuro

Ensino médio

O ensino de nível médio prepara o jovem para os desafios do mundo do trabalho e o exercício da cidadania.
Time As Unidimensional Space
Multiple construals: usual taxonomy

- Two main conceptual metaphors (Criterion: What moves?) (Clark, 1973, Lakoff, 1993; Gentner, 2001)

1. “Ego-moving”
   - We’re coming to the end of the year

2. “Time-moving”
   - Thanksgiving is approaching
1. Ego-moving Mapping

Source Domain
1-D Space

- front of ego
- behind ego
- ego’s location
- ego’s motion

Target Domain
Time

- future
- past
- present/now
- passing of time

The diagram illustrates the mapping between the source domain of 1-D space and the target domain of time, focusing on the ego's movement and its spatial and temporal relationships.
2.- Time-moving Mapping

Source Domain
1-D Space

- front of ego
- behind ego
- ego’s location
- motion of objects

Target Domain
Time

- future
- past
- present/now
- passing of time
Moving-Ego, Moving-Time
Too simplistic?

- The class meetings are too close together
  - [no motion]

- It is 20 minutes ahead of 1pm
  - [Ego is not the RP]

- Spring follows Winter
  - [no Ego, no “Now”, no present]
“Ahead”? 

1. “Ego-moving”
   - The week *ahead* of us

2. “Time-moving”
   - *It is 20 minutes ahead* of 1pm
But *ahead* OF WHAT?

- Reference Point! (not motion per se)
  
  1. “Ego-RP”
     - *The week ahead of US* (LATER)
  
     - *It is 20 minutes ahead of 1PM* (EARLIER)
Time-RP Mapping

Source Domain
1-D (Ego-free) Space

Target Domain
Time

front of object

behind object

(some object)

earlier (than Now)

later (than Now)

(present/now)

Moore, 1999
Núñez, 1999
Núñez & Sweetser, 2006
Examples of Time-RP

- Spring follows winter
- Before/After 1945
- PAST mapped with FRONT (relative to object)
  - The day before yesterday
  - Avant-hier
  - Antes de ayer

- FUTURE mapped with BACK (relative to object)
  - Con posterioridad a 1950
Time As Unidimensional Space: Time-RP mapping

“The day before yesterday”
FRONT mapped with PAST (relative to object)

“Con posterioridad a 1950”
BACK mapped with FUTURE (relative to object)
A new taxonomy
Criterion: Reference Point

Núñez & Sweetser, 2006
Núñez, Motz, & Teuscher, 2006
Spatial Construals of Time

An essential construal of chronological experience (time) is built through a fundamental conceptual metaphor:

- **Time AS Unidimensional Space**
- Its general form is universal: construals are indeed *Spatial*

It has (at least) two forms

1. **Ego-RP** (front/future – back/past)
2. **Time-RP** (front/earlier – back/later)

Inferences (“truth”) are relative to the mappings
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Aymaras
Where do Aymaras live?
South American Andes

Highlands
Aymara: Expressions regarding the past

**ancha nayra pachana**

Morpheme by morpheme gloss:

- *ancha*: a lot
- *nayra*: eye, sight, front
- *pacha*: time
- *-na*: in, on, at

Literal translation:

A lot eye/front time-at

Meaning:

(At a) long time ago
Aymara: Expressions regarding the future

**akata q”iparu**

Morpheme by morpheme gloss:

- *aka*: here, this
- *-ta*: from
- *q”ipa*: back, behind
- *-ru*: to, towards

Literal translation:

Here/this-from back-to

Meaning:

From now on
Spatial construals of time in Aymara
The crucial question

- Lexical and metaphorical evidence of
  - Time AS Unidimensional Space metaphor
- But …

In Aymara, is the underlying mapping Ego-RP or Time-RP?
Spatial construals of time in Aymara
The crucial question

- If the mapping is **Time-RP** then it simply operates like our “ahead” (front/Earlier – back/Later)
  - Many “exotic” languages thought to be counter-universal turned out to be like English, after the Time-RP distinction (Moore, 1999; Núñez & Sweetser, 2006).

- If the mapping is indeed **Ego-RP** then Aymara would be a **counterexample** to the universality of Ego orientation!
Spatial construals of time in Aymara
How to decide?

- Because of grammatical constraints in Aymara there is no way to answer to the previous questions with purely linguistic evidence (e.g., grammatical, lexical, …) (Hardmann, 2001)
- There are no clear and unambiguous cases such as
  - “The week ahead of us” (meaning future in front of EGO rather than of another time)

Spontaneous gestures?
What can we learn from Gestures?

- A detailed study of Gestures can help answering the previous questions
  - Gesture-speech co-production is universal
  - Astonishingly close speech-gesture co-production
  - Provide rich information about deixis, manner, and RPs (often complementary to speech)
  - Preservation and construction of semantics (iconics and metaphorical gestures): built-in
... más allá antes ...
“From last year to this year”
“From last year to this year”

[... to this year]  
... a este año
And much more ...

Nayra mara ... antiguo [old]

Aka maran [this year]

Q”ipa timpun [Future times]
And much more …

Last year’s  nayra sata  taypi sata  q”ipa sata
Micro movements … with transitive relations (order)

nayra sata  taypi sata  q”ipa sata
Time As Unidimensional Space: Aymara Ego-RP mapping

Source Domain
1-D Space

Target Domain
Time

Converging lexical, metaphorical, AND gestural evidence
Sagittal Past gestures

Aymara participants producing sagittal past gestures (n=15)

<table>
<thead>
<tr>
<th>Language Proficiency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aymara - Castellano Andino speakers (no grammatical Spanish)</td>
<td>Past-Front only</td>
</tr>
<tr>
<td>Spanish speakers (bilinguals or monolinguals)</td>
<td>Past-Front only</td>
</tr>
</tbody>
</table>

Fisher’s, $p = 0.035$

Núñez & Sweetser, 2006
A counter-universal!

GEO Wissen

The New York Times

Jornal do Brasil

Taipei Times

Pour la Science
A case of a dying metaphor?

Aymara participants producing only sagittal past/future gestures (n=10)

- Past-Front or Future-Behind gestures
- Past-Behind or Future-Front gestures

Núñez, Neumann, & Mamani, 1997
Núñez & Sweetser, 2006

Fisher’s, $p = 0.024$
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An ambiguous case ... 

- The Wednesday meeting was moved forward two days. When is the meeting now that it has been re-scheduled?
An ambiguous case …

- The Wednesday meeting was moved forward two days. When is the meeting now that it has been re-scheduled?
  - Monday (45%)
  - Friday (55%)

McGlone & Harding, 1998
Boroditsky, 2000
Priming an ambiguous case ...

- Priming the source domain should

  - increase “Monday” responses (Time-moving)
    “Because the event moves towards ego”

  - increase “Friday” responses (Ego-moving)
    “Because the event moves in ego’s direction of motion”

Boroditsky, 2000
Boroditsky & Ramscar, 2001
The psychological reality of Time-RP: Experimental manipulation

- Priming with an EGO-free sequence
  - Prediction: should increase “Monday” responses

- Two conditions:
  - Future question
  - Past question
Two questions: Future and Past

- **Next Wednesday** meeting was moved forward two days.
- **Last Wednesday** meeting got moved forward two days.

"Towards ego":

Front of Sequence: Monday

"Towards ego":

Front of Sequence: Friday

Front of Monday
Priming (Exp 1)

Núñez, Motz, & Teuscher, 2006

2x2 Right-Left priming
\( \chi^2(1, N=66) = 0.26, p = 0.61 \)

Monday vs. Friday:
\( \chi^2(1, N=66) = 8.56, p = 0.0034^{**} \)

Núñez, Motz, & Teuscher, 2006
Priming (Exp 2)

$\chi^2(1, N=45) = 6.58, p = 0.01^{**}$

$\chi^2(1, N=45) = 0.002, p = 0.96$

Núñez, Motz, & Teuscher, 2006
The psychological reality of Time-RP

- Priming with an EGO-free sequence increases “Monday” responses
- People disambiguate “forward” not because of Ego (“towards”), but because of the orientation intrinsic to the sequence
  - Past question provides the dissociation
- Priming direction doesn’t matter
- Ego-RP and Time-RP are psycho-cognitively two different metaphorical mappings
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Looking for neural basis:
Anatomical hypotheses

- What neural populations dealing with body-centered space may be recruited for specific temporal meaning (e.g., Ego-RP)?
  - Ventral Intraparietal area (VIP)
    - in the intraparietal sulcus
  - Polysensory Zone (PZ)
    - in the precentral gyrus
VIP and PZ

- Multimodal neurons
  - Respond to objects touching, near, or looming toward the body surface

- Participate in
  - Navigation by optic flow
  - Attention to nearby space
  - Processing for object location for the guidance of movement

- Somatotopically (not only retinotopically) organized
  - Body-centered

- Densely interconnected
Stimulation of VIP and PZ in monkeys

Electrical stimulation evokes defense-like withdrawing or blocking movements. Suggested to play a role in immediate awareness/safety around the body.

Graziano & Cooke, 2006
PZ neurons

which responded to:
- tactile stimuli on the front of the face
- visual stimuli near the face

Graziano, Hu, & Gross, 1997
Head-centered Representation in VIP

Head-centered coordinates

Toward Forehead from Above with Eyes Up

Toward Chin from Above with Eyes Up

Toward Chin with Eyes Down

Fig. 7. Head-centered spatial coordinates in VIP. Changes in eye position do not change selectivity for stimuli moving towards the chin.

Jean-Rene’ Duhamel, Frank Bremmer et al. 1996, Nature

Carol L. Colby & Jean-Rene’ Duhamel, et. al, 1996
Multisensory area in Superior Parietal Cortex (visual-somatosensory)
Aligned somatosensory and visual maps for a single subject (dorso-lateral view)

Sereno and Huang, 2006
Aligned somatosensory and visual maps for single subjects (dorso-lateral view)
Putative Human VIP

Sereno and Huang, 2006
You are approaching Christmas vs. Christmas is approaching

Auditory cue

Núñez, Huang, & Sereno, 2007
You are approaching Christmas
vs.
Christmas is approaching

Auditory cue

Núñez, Huang, & Sereno, 2007
Eccentricity Mapping (center ➔ periphery)

Núñez, Huang, & Sereno, 2007
Time (is approaching):

VIP

VIP

Núñez, Huang, & Sereno, 2007
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Conclusions

- Construals of time appear to be universally based on 1-D space
- The study of construals of time can/should be
  - Theoretical
  - Empirical
    - Cross-linguistic (lexical, metaphorical)
    - Ethnographic
    - Gestural
    - Experimental
      - Psychological, behavioral (e.g., priming)
      - Neuroimaging
Conclusions

- Two main conceptual mappings model the construals (reference points):
  - Ego-RP ("quasi-universal")
  - Time-RP (universal ... so far)
- The inferential systems are relative to the organization of the mappings (e.g. "forward")
Conclusions

- **Ego-RP**: Aymara: first well-documented case of an exception to the “rule”
  - Empirical evidence: Lexical, metaphorical, ethnographic, gestural
  - Universal bodily experiences, allowing cultural variation
  - Internal “logic”? necessary but not sufficient: overemphasis of visual experience and evidentials

- **Time-RP**: Is it more primitive?
  - no (necessary) “Now”
  - Only *later* and *earlier than* relations
Conclusions

- Neural basis
- fMRI and neuroimaging
  - VIP/PZ areas may play a crucial role in making Ego-related spatial construals of time possible
Thanks!

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