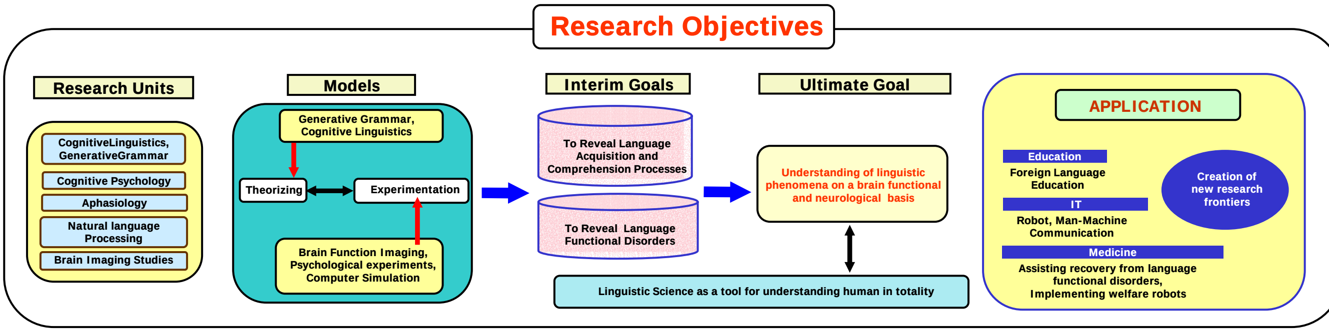
The Tohoku University 21st Century COE Program in Humanities

Strategic Research and Education Center for an Integrated Approach to

Language, Brain and Cognition

Research Objectives



BRAIN MAPPING

Yuko Sassa, Naho Ikuta, Motoaki Sugiura, Jobu Watanabe, Yuko Akitsuki, Kazuki Iwata, and Ryuta Kawashima

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The recent advantages of functional imaging techniques enable us to visualize the brain activity associated with cognition in normal subjects. Recently, many functional imaging studies investigated the brain areas involved in language processes in the human brain(e.g. sentence comprehension). Here we present the results of our recent two experiments determined brain regions involved in visual or auditory sentence comprehension using functional magnetic resonance imaging (fMRI).

Brain Areas Associated with the Processing of Sentence: Reading a Sentence

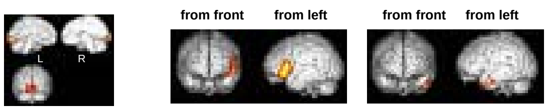
Reading

SUBJECT — e.g. *Yasuko-ga* (Person's name + subject case particle)

OBJECT — e.g. *gasu-wo* (the gas + object case particle)

VERB — e.g. *kesu* (turns off)

from medial / from back; from front / from left; from front / from left



Left lingual gyrus — Left inferior frontal gyrus — Left inferior temporal gyrus

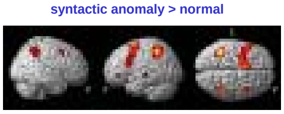
Healthy volunteers were instructed to read the visually presented sentences silently during fMRI measurements. As a result, we found that different brain areas were activated in turn, that is, from a subject to a transitive verb, during visual sentence comprehension.

Brain Areas Associated with Syntactic Anomaly or Semantic Anomaly: Listening to a sentence

Listening

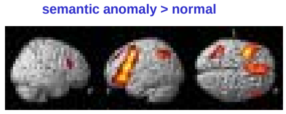
compared anomalous sentences with normal sentences

syntactic anomaly > normal



Left middle frontal gyrus
Bilateral inferior parietal lobule

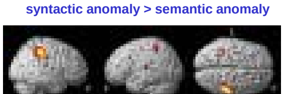
semantic anomaly > normal



Left inferior, middle and superior frontal gyri
SMA (supplemental motor area)

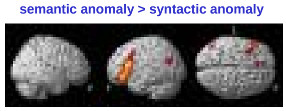
task versus task comparison

syntactic anomaly > semantic anomaly



Right inferior parietal lobule

semantic anomaly > syntactic anomaly



Left inferior frontal gyrus

Healthy volunteers were instructed to hear the auditory presented sentences and to judge whether a sentence was acceptable regardless of syntactic anomaly or semantic anomaly. As a result, we found that both syntactic and semantic processing were collaborated with the same front-parietal networks, although the magnitude of activation of the brain areas consisted of these networks were slightly different in accordance with those language processing.

COGNITIVE-FUNCTIONAL LINGUISTICS

Reconstructing Temporal Structures in Korean Texts: A Contrastive Study with Japanese

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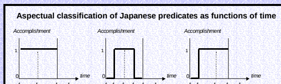
Graduate School of International Cultural Studies

- **Within the context of Japanese/Korean linguistics, relatively underrepresented are:**
  Attempts to analyze Japanese and Korean tense-aspect systems employing:
  1. **A theoretical model/framework applicable to both languages;**
  2. **A large corpus of digitized texts available in both languages**
- **Sato, Kumamoto and Sato (2001):**
  presents a theoretical model of textual/pragmatic functions of past and non-past tense markers occurring in "scene-depicting text", which is referred to as the "Time Progression Model" (TPM):
  Scene-depicting text
  "a kind of narrative where the writer recalls and depicts a series of events in the past, and the reader, on the other hand, reads the text and reconstructs the events"
- **The purpose of this paper is:**
  1. **Extend the TPM to Korean texts and examine its cross-linguistic applicability**
  2. **Investigate how the Korean tense-aspect system differs from its Japanese counterpart, and propose an extension of their model by incorporating the observed cross-linguistic differences**

The Time Progression Model (TPM)

Aspectual classification of Japanese predicates as functions of time



(a) Stative predicate, (b) Action predicate, and (c) Transition predicate; [t_0, t_1] denotes the observation interval, t_r the point of reference, t_j the starting point of an action, t_k the finishing point of an action, t_s the point of utterance. Given a time point, this "accomplishment" function returns either one of the two values for an event/state, 1 for "Accomplished" or 0 for "Unaccomplished".

	Past tense form	Non-past tense form
Action predicate	Create a time frame and advance time	Describe objects/states in the time frame
Transition predicate		
Stative predicate	Shift the target of description	

Functions of matrix predicates in the TPM

Past tense forms of Action/Transition predicate (A/p, T/p) => **Advancing time**

Past tense forms of Stative predicate (S/p) and Non-past tense forms of Action/Transition/Stative predicate (A/n, T/n, S/n) => **No time advancement**

Analysis of a Korean text in terms of the TPM

[1]	1: T/p	**Time advancement**	*I-kyoli-ka ... ppalu-n kel-um-ulo pataska-lul* (-NOM) *hyanghaye* *naka-ss-ta*. (go out-PAST- DECL)	Ikyoli…walked out with quick steps to the beach.
	2: A/n	**Object/state description**	*I-kyoli-ka ... twullepo-ni ..., han kos-un iwus tongli-uy epwu-tul-i ... twulenkeli-nta*. (fisherman-PL-NOM whisper-DECL (non-past))	As Ikyoli looked around … at some place fishermen in the neighboring village whispered something.
	3: S/n	**Object/state description**	*salam-ul phiha-lye-nun I-kyoli nwun-ey-nun ..., salam eps-nun kos-i* (person not exist-ADN place-NOM) *eps-ta*. (not exist-DECL (non-past))	In the eyes of Ikyoli, who tried to avoid others,…there was no place where there was no one.
[2]	4: T/p	**Time advancement**	*I-kyoli-nun ... salam-i eps-nun celpyek-ul* (-TOP cliff-ACC) *chacao-ass-ta*. (find-PAST-DECL)	Ikyoli…found a cliff where there was no one.
[3]	5: T/p	**Time advancement**	*... patasmwul-ul naylye-ta-po-nikka hanpen momseli-lul chi-ko phyelssek cwuceanc-ass-taka tasi ... sesehi ilese-ss-ta*. (slowly stand up-PAST-DECL)	…, (Ikyoli) trying to dive into sea, once shivered and sat down, with his legs failing him…(he) slowly got up.
[4]	6: T/p	**Time advancement**	*I-kyoli-ka ... mom-ul soschi-lye ha-lcey ku twi-eyse 'eyheym!' kichimsoli-ka na-ss-ta*. (sound of cough-NOM come out-PAST-DECL)	When Ikyoli was about to force himself to jump, he heard someone behind him clear his throat.
	7: S/p	**Target shift**	*... cwuincip ai-ka ... nwunaph-ey* (Master's house child-NOM) *se iss-ess-ta*. (stand-PERF-DECL)	…a child of Ikyoli's master was standing in front of his very eyes.
[5]	8: A/p	**Time advancement**	*I-kyoli-nun ... celi ka-lanun ttus-ul poi-ess-ta*. (will-ACC show-PAST-DECL)	Ikyoli showed his will (for the child) to go away.

(Numerals in square brackets indicate time frames. Italicized sentences are of the Korean original text.)

- **Our data:**
  Digitized Korean novel texts (approximately 70KB)
- **Our finding:**
  Out of 361 instances of Korean predicates under investigation, 333 instances (92.2%) were shown to serve functions proposed in the TPM
  → The TPM is applicable to Korean data
- **Temporal reconstructing functions of the Korean *hayssessta***

☐ **Korean has the so-called "past-past tense" suffix essess-, wherein the past tense morpheme -ess- is repeated, as in ha-ess-ess-ta (do-PAST-PAST-DECL), i.e. the "hayssessta form"**
-- one of the most remarkable differences between Korean and Japanese temporal systems

☐ **Two textual functions of the hayssessta forms:**

◇ **"scene switching" function**
(mediated by temporal adverbials)

◇ **"time reversing" function:**
temporarily refers to an event/state occurring prior to the scene frame dveloped up to the immediately preceding sentence.

SPEECH AND LANGUAGE ENGINEERING

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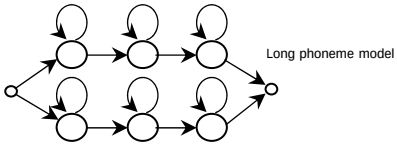
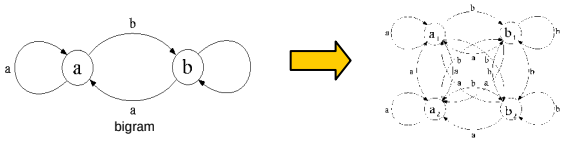
- **The Topics of the unit**
  - Acoustic models for speech recognition
  - Language models for speech recognition
  - Spoken dialog system for mobile robots
  - Multi-modal interaction system for mobile robots
  - Computer-aided language learning system using speech recognition technology
- **Acoustic models**
  - HMM(Hidden Markov Model)-based model
  - 
  - Acoustic model for spontaneous speech: long-duration model and short-duration model

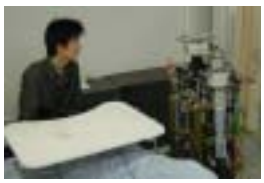


Short phoneme model (affected by coarticulation)

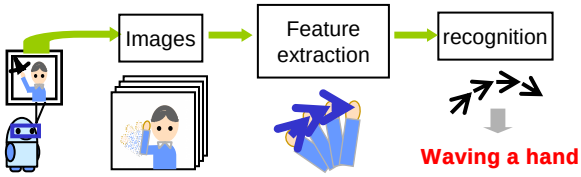
- **Language models**
  - HSn-gram: a language model based on n-gram model
    This model extends an N-gram model (N-testable finite state automaton) into a nondeterministic finite state automaton (equivalent to an Ergodic HMM)



- **Spoken dialog system for mobile robots**
  - A dialog system for the intelligent care robot `IRIS'



- **Multi-modal interaction system for mobile robots**
  - Gesture recognition using 2-dimensional warping



- **Computer-aided language learning system using speech recognition technology**
  - Japanese language learning system for Korean native speakers

COMPUTATIONAL LINGUISTICS

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- **The Topics of the Unit:**
  - **Linear sentence processing model:**
    Floating quantifiers
    Working memory's influence on syntax
  - **Computer-aided language learning.**
- **Linear Sentence Processing Model**
  - **Dynamic Syntax** (Kempson et al. 2001):
    Incremental parsing: Interpretations can be left underspecified in the course of parsing.
    A sentence processing model which introduces and cancels memory load from left to right.
- **Floating Quantifiers**
  - Floating quantifiers (FQs) in Japanese – accounts based on syntax and information structure.

(1) Hon-o John-ga san-satsu katta.
book-Acc John-Nom three-Cl buy-Past
"A student bought three books."

(2) gakusei-san-ga sono-zasshi-o go-nin katte itta.
student-Hon-Nom the-magazine-Acc five-Cl bought away
"Five Students came to buy the magazine."

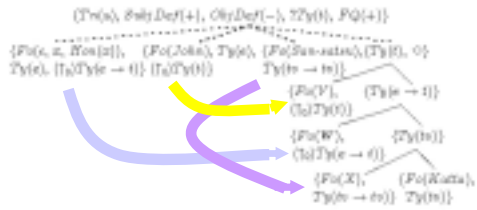


Figure 1: Parsing tree of (1) *Hon-o John-ga san-satsu katta.*

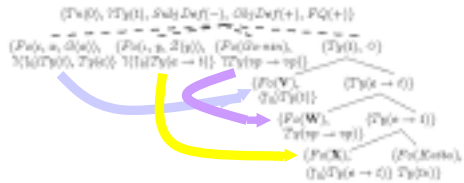
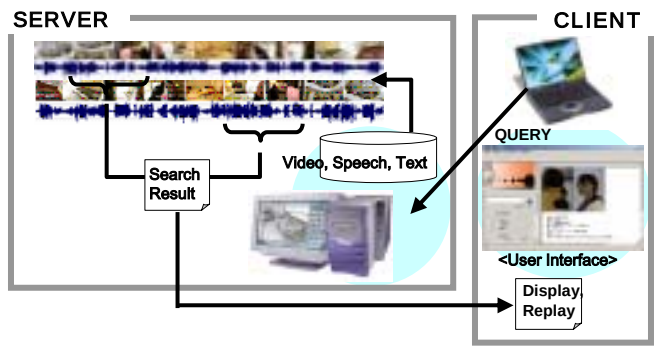


Figure2: Parsing tree of Takami's example (2)

- **The dotted line**: node address is not fixed.
- The lexical items: '**IF S_1, THEN S_2, ELSE S_3**'.
- Out Solution:
  The verb introduces a sub-tree with an appropriate type construction reflecting information structure-based constraints.

- **Multimedia Collocation Retrieval System**
  - Multimedia collocation retrieval system for the learners of Japanese
  - The text data combined with speech and video information is provided by an on-demand real-time server-client environment



<Multimedia Collocation Retrieval System>