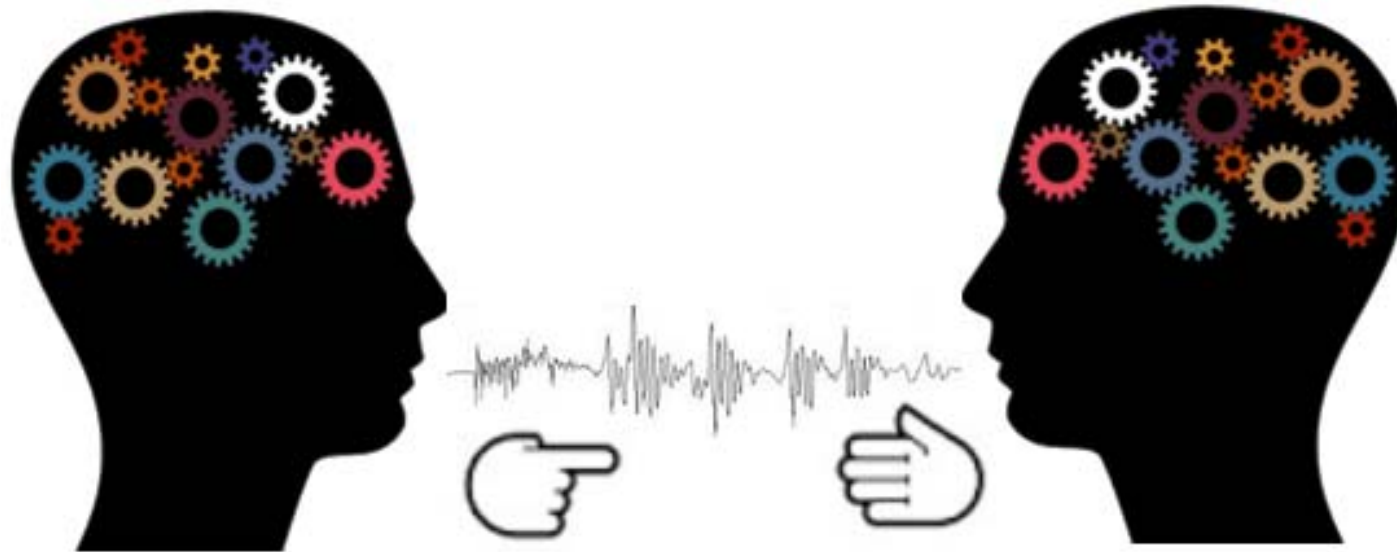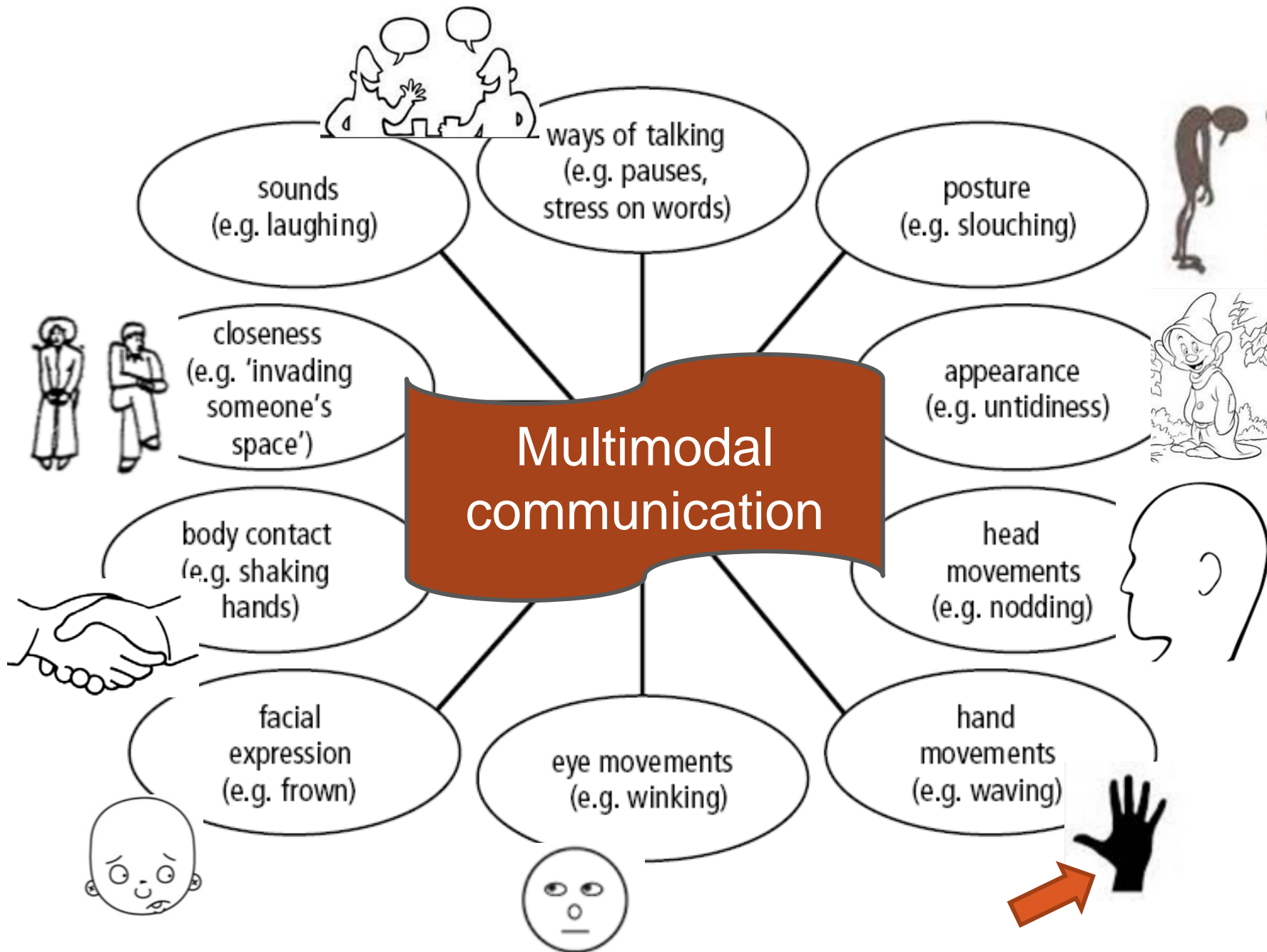# EXPLORATION OF THE NEURO-COGNITIVE BASIS OF LANGUAGE AND GESTURE

探索語言─手勢之認知神經基礎

Why people gesture when they speak

Iverson, J. M. & Goldin-Meadow, S.

Nature, 1998, *396*, 228

Do speakers gesture simply because they see others gesture, and learn from this model to move their hands as they talk?

I	12 congenitally blind speakers	⟷	a sighted experimenter
II	12 sighted speakers	⟷	a sighted experimenter
III	4 congenitally blind speakers	⟷	a blind experimenter

ENGLISH BLIND VS. SIGHTED SPEAKERS

- Blind speakers gestured.

- Blind & sighted people's speech production was similar.

- Their gesture production was similar.
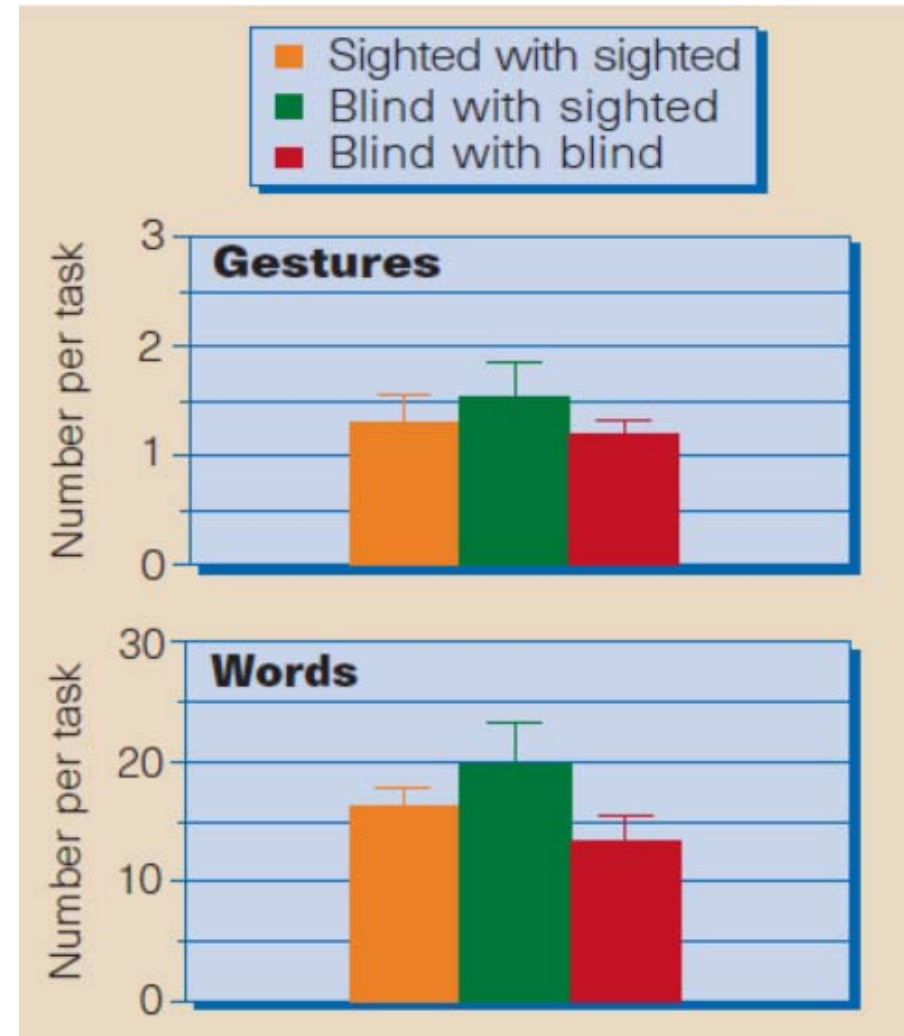
People speak in different ways, and they also gesture in correspondingly different ways.

Do blind people of different languages produce language-specific gestures? Or do they gesture in the same generic way because of the lack of input?

Is seeing gesture necessary to gesture like a native speaker?

Şeyda Özçalışkan, Ché Lucero, and Susan Goldin-Meadow

Psychological Science, 2016, *March*

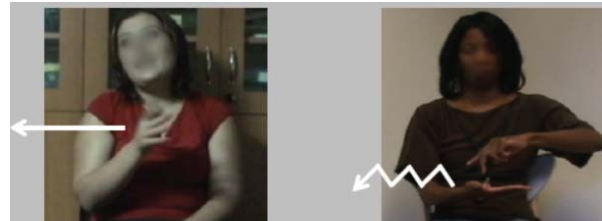English: 20 congenitally blind adult native speakers

Turkish: 20 congenitally blind adult native speakers

Experimental task: Descriptions of physical motion

He <u>rolled down</u> (the hill).
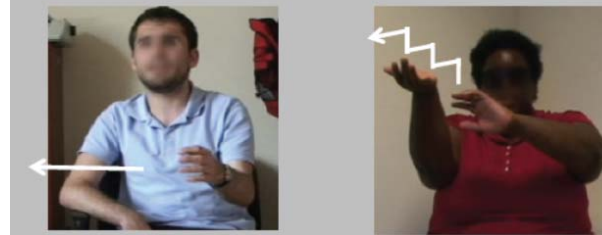
He <u>descended</u> as he <u>rolled</u>.

Sighted speakers

Sighted speakers with blindfolds

Blind speakers

Language-specific expression of motion event

- Blind English adults speak and gesture like sighted English adults.

- Blind Turkish adults speak and gesture like sighted Turkish adults.

- Speech and gestures are language-specific.

Where do the cross-linguistic differences in gesture come from?

- By watching other speakers gesture?

  Blind people can't see.

- By learning to speak a particular language?

  By hearing the language is sufficient for blind people to gesture like a native speaker.

Linguistic-gestural communication

- Linguistic-gestural communication is a fundamental type of social interaction in our daily life.

- Idiosyncratic spontaneous movements of hands and arms accompany a speech event with context-dependent meaning and use.

- People speak and move their hands and arms simultaneously when they communicate semantic information.
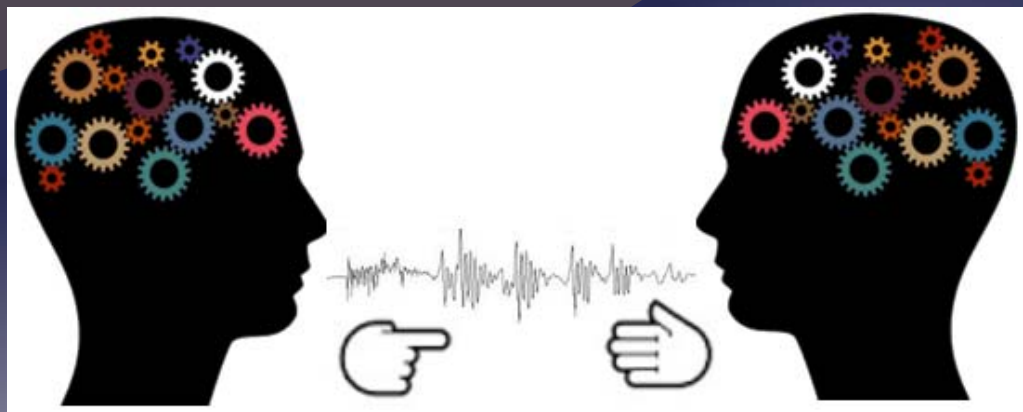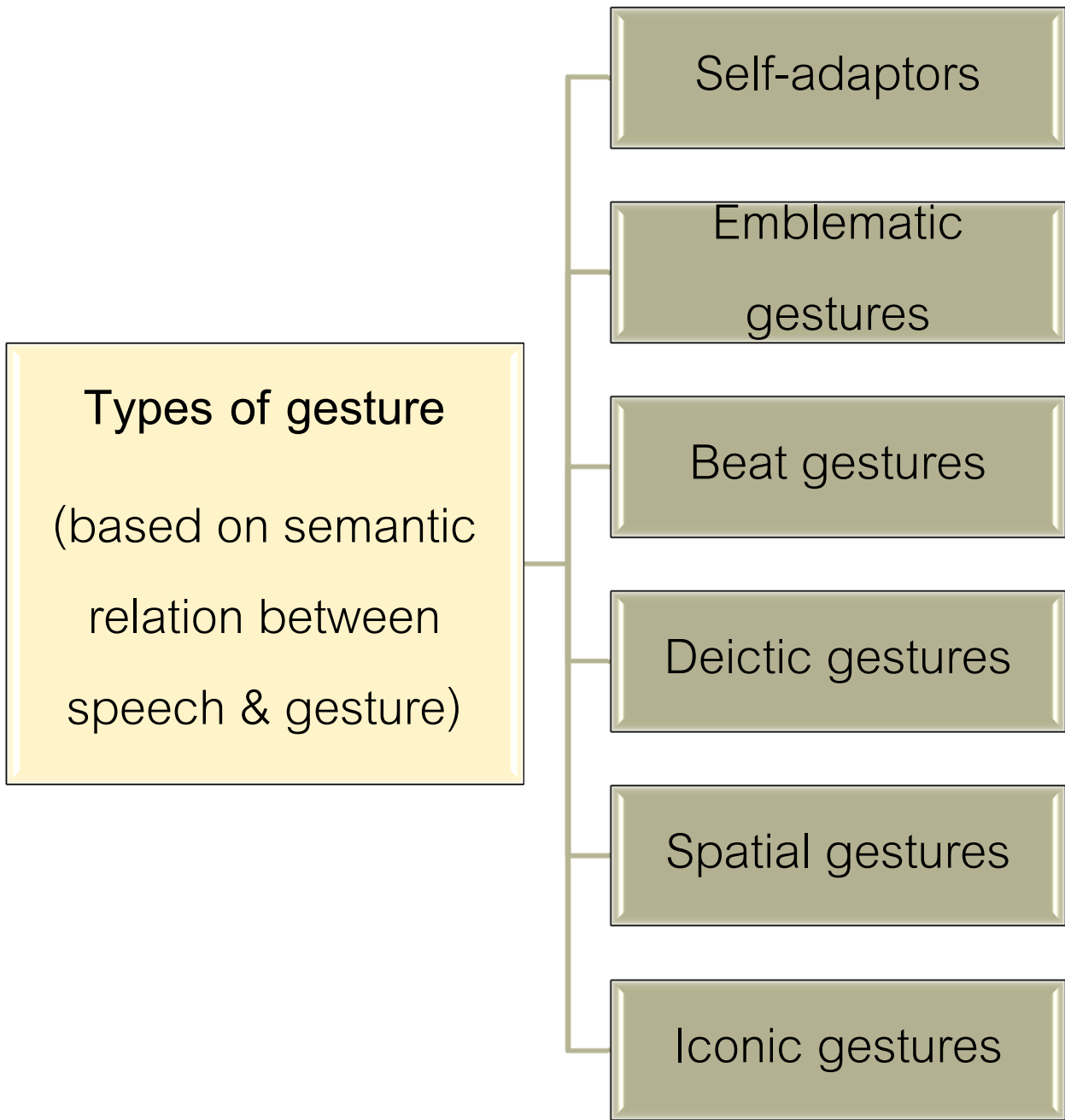
- Does that mean language and gesture always come together?
- Do they form ONE SINGLE SYSTEM or TWO SEPARATE BUT HIGHLY INTERACTIVE SYSTEMS?
- Will the integration be affected by different types of gesture?

TYPES OF GESTURE

Types of gesture
(based on semantic relation between speech & gesture)

- Self-adaptors
- Emblematic gestures
- Beat gestures
- Deictic gestures
- Spatial gestures
- Iconic gestures

Self-adaptors

They are self-touching movements, such as scratching on the arm or removing something that got into the eyes.
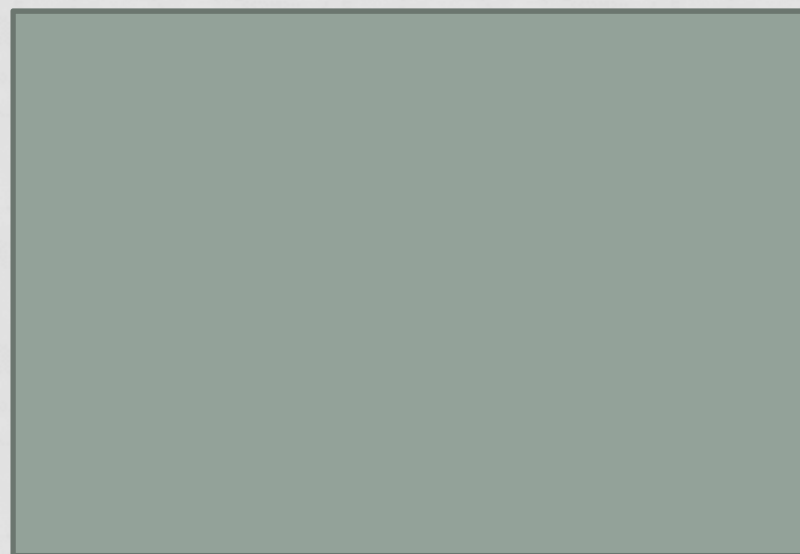
F: ..沒有開冷氣也會
啵啵啵

M: ..對啊...所以才說
是老鼠

Emblematic gestures

They have socially agreed-upon standards of well-formedness and are reproduced in much the same way across users of a particular language, e.g. OK gesture, enumeration gesture.
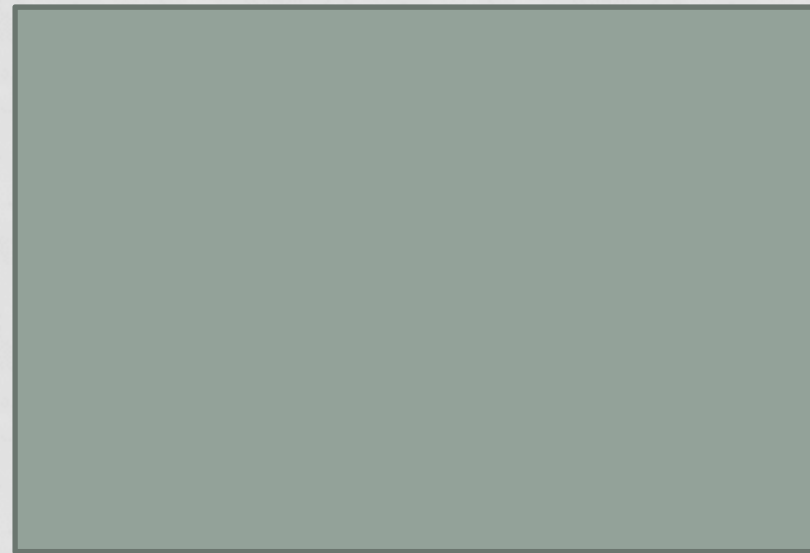
F: ..會帶她們的考卷..
或複習的考卷..然
後在..就是數學啊
理化啊還有英文

Beat gestures

The hands move along with the rhythm of speech, typically small up and down or back and forth flicks of one or both.
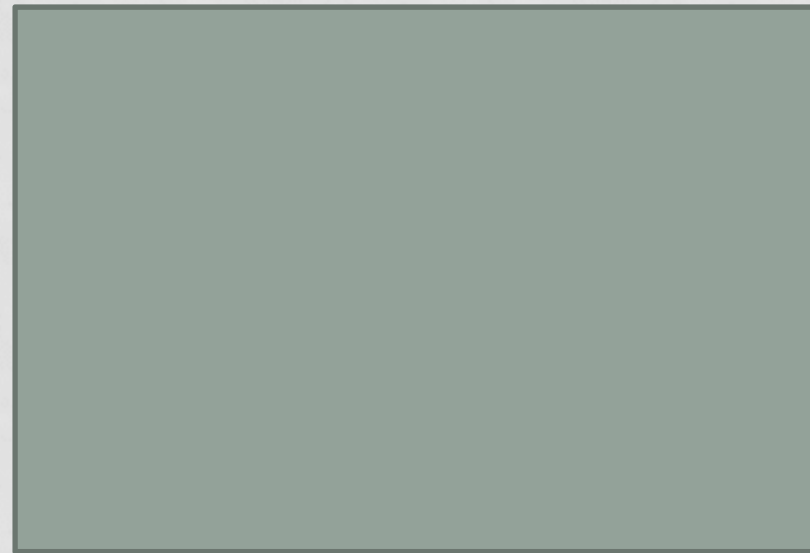
M1: 他就是是邀那個..邀
鄔瑪舒曼然後跳舞..
然後兩個就開始跳..
那邊超讚

Deictic gestures

They point at a referent in the immediate speaking environment.

F1: ..你們國中頭髮..
　　可以留那麼長嗎

Spatial gestures

They designate a space for a referent not present in the immediate speaking environment.

F1: ...然後我就...拿一
個公文...送到...行
政大樓...送回來...
送去社資中心
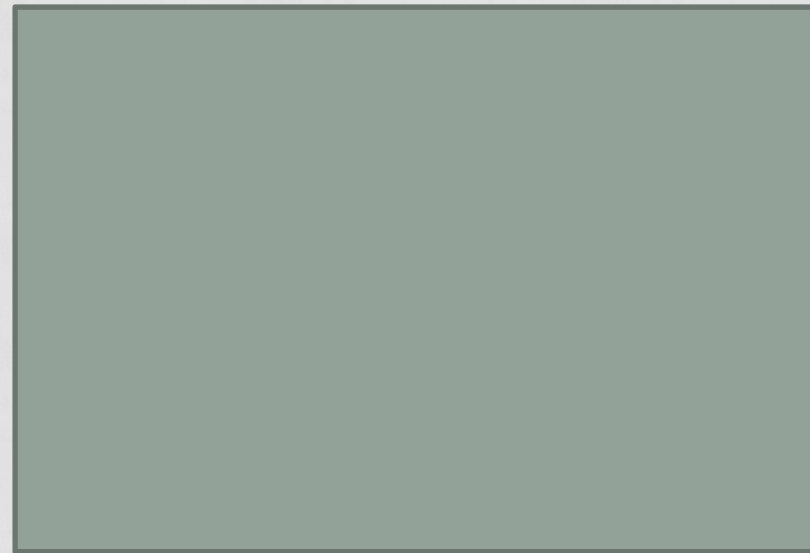
Iconic gestures

They depict the meaning of a concrete idea.

F1:　　..就是我有朋友來我都會跟他說..唉你看..我房間窗戶
　　　有蜂窩耶
F2:　　..是虎頭蜂的唷.. 你要不要打開來看看
F1:　　沒有沒有那時候..那時候我不知道他是虎頭蜂

Metaphoric gestures

They depict the meaning of an abstract idea.

M1: ..題目的深淺度就是..比較有差...對啊..就才會差在這個地方啊..就方向都還算對準備的方向都還算對
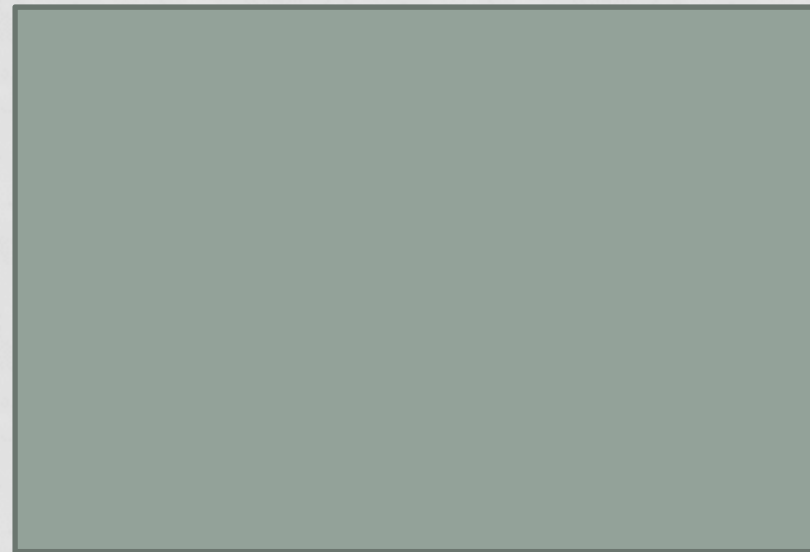
PURPOSE OF THE TALK
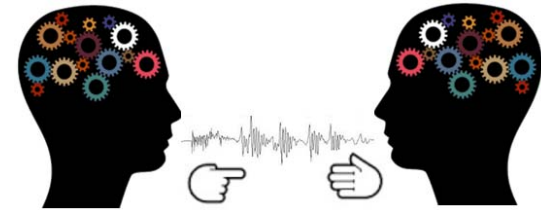
CONTEXTUALIZATION OF

ICONIC/METAPHORIC GESTURE

IN DAILY CONVERSATION

A THOUGHT MUST HAVE BEEN FORMULATED

BEFORE INFORMATION IS ORGANIZED ACROSS

SPEECH & GESTURE

TAKE A TISSUE 拿衛生紙

F: ...甚至小的蟑螂...我還敢...直接...就拿衛生紙...就把它捏死

TAKE A COCKROACH'S ANTENNA 拿鬚鬚

F: …就是那個..蟑螂 s-…把它打死..拿拖鞋打死…然後拿鬚鬚..
拿起來就丟掉

TAKE AWAY PAPER PLATES 拿走紙盤

F: ..我告訴你..我覺得...你這樣紙盤...一個..拿走以後

TAKE AWAY BOWLS OF FOOD 拿走一碗一碗生菜

F: ...我就說...其實那個生菜..我們就切一切..然後把它放好...一碗一碗...你要..就拿走

How is meaning expressed across speech and gesture in face-to-face interaction?

Gesture associated with speech

F2:　..開車下山啊

GESTURE NOT ASSOCIATED WITH SPEECH

Near-universal motion components:

他就從我旁邊走過去
Figure 他
Ground 從我旁邊
Motion & Manner 走
Path & Direction 過去

他們兩個走路	Speech	Gesture
Figure	他們	---
Ground	---	---
Motion & Manner	走路	---
Path & Direction	---	LH moves upward toward RH

Language and gesture in co-construction of meaning

JOINT ACTIONS FOR CONSTRUCTION OF MEANING

- In daily conversation, a common language use is to construct meaning for communication, which can be accomplished via the collaboration between participants.

- Mimicked gestures are used along with speech for the joint construction of meaning.

Herbert Clark, Emeritus Professor of Psychology at Stanford University
He studied speaking, understanding, and memory in conversation.

Speaker's presentation of information

- 其實他本來就蠻會那個啊

Addressee's collaboration response

- 還蠻能調節就對了

Speaker's acknowledge-ment

- 對啊..他..他也是有胖瘦胖瘦胖瘦..這樣

Time metaphors across speech and gesture

THE TANGLE OF SPACE AND TIME IN HUMAN COGNITION

NÚÑEZ & COOPERRIDER

More and more cognitive scientists and cognitive linguists have noticed the importance of gesture in linguistic studies.

TIME IS SPACE IN METAPHOR STUDIES

 "Analysis of spontaneous co-speech gesture, which is ubiquitous in humans and occurs naturally without elicitation, offers an especially fruitful complement to careful linguistic analysis in small-scale groups. Gesture can convey fine grained properties of construals (such as their particular three-dimensional geometry), which would not be possible to investigate within the confines of an arrangement task" (p.225).

Alignment
between language and gesture

STATE OF CONFUSION IS AN ENTITY

<u>Metaphoric object in speech</u>
如果要避免我剛剛講那種失控的狀況的話

<u>Object gesture</u>
A cupped shape with slightly curled fingers as if holding a bounded object in the hand.

The metaphoric speech and metaphoric gesture align simultaneously in manifesting the conceptualization of an abstract idea as an object.

Non-alignment
between language and gesture

TIME IS AN ENTITY in speech

Time-stationary perspective

你懷孕期這段時間..你還有時間可以做心理準備

TIME IS MOTION in gesture

Time-moving perspective

The hand is the time object moving along the time line from center to the right.

TIME IS SPACE in speech and gesture

	Speech	Gesture	
Earlier time	FRONT 因為之前那時候還沒有Lamigo 球隊	LEFT	
Earlier time	FRONT 其實在他們兩個之前最快是什麼像三振啊	RIGHT	
Later time	BACK 我畢業後一年起第一屆才有推甄	FRONT	

Different spatial axes to distinguish times:

Speech	Gesture
Front-back	Front-back
Up-down	Up-down
	Left-right

METAPHORIC CONCEPTUALIZATION UNDER THE INFLUENCE OF THE VARIOUS CULTURALLY SPECIFIC WRITING AND READING PRACTICES

	Writing	Reading
English	left → right	left → right
Hebrew	right → left	right → left
Chinese	top → bottom & right → left left → right	top → bottom & right → left left → right

The simultaneous realization of time metaphors across the two modalities reveals much more detail about the conceptualization of time concepts than either modality can alone:

- Complexity in conceptualization
- Modal specificity
- Cultural specificity

	Congruous gesture	Incongruous gesture
Kelly et al. (2004)	smaller N300 and N400	larger N400 component
Wu & Coulson (2005, 2007)	N400 effect being sensitive to both linguistic and gestural contexts	
Cornejo (2009)	L+G integration at an early stage of metaphor comprehension	
Holle and Gunter (2007)	L+G integration is modulated by the proportion of meaningful and meaningless hand movements	
Kelly et al. (2007)	L+G integration is modulated by the pragmatic knowledge about the intentional relationship between gesture and speech	

General understanding

- Speech and gesture are integrated during language processing, but it does not seem to be a purely automatic process.

- The cross-modal integration can be modulated.

➢ Do different types of meaning in gesture affect the integration?

# COMPREHENSION OF GESTURE:

FMRI STUDIES
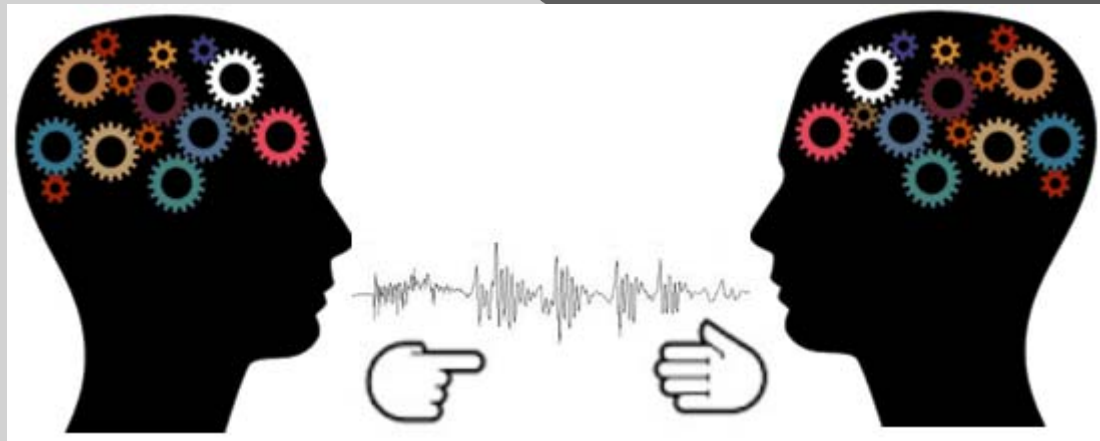
	Iconic gestures	Metaphoric gestures	Emblematic gestures	Deictic (& spatial) gestures	Beat gestures	Self-adaptors
Skipper et al. (2007)	SMG, PPMv, PPMd, STa	SMG, PPMv, PPMd, STa	---	SMG, PPMv, PPMd, STa		POp, PPMv, STp
Holle et al. (2008)	left STS	---	---	---		---
Kirchera et al. (2009)	---	left posterior MTG, IFG, BA6, right STS	---	---		---
Xu et al. (2009)	---	---	left posterior MTG, IFG	---		---
Lindenberg et al. (2012)			left inferior frontal, medial frontal, & posterior temporal cortices, the cerebellum, regions related to semantic processing, and medial prefrontal areas			
Straube et al. (2012)	left IFG, left ITG, right MTG	---	---	---		---
Dick et al. (2014)	IFGTr, IFGOp, MTGp					
Bernard et al. (2015)		cortical brain regions related to gesture production & understanding			cerebellar regions related to motor functioning & motor networks	

What is still not known

- Most of the studies focused on iconic gestures. What about other types of gesture that are prevalent in daily speech communication?

- Which part(s) of the brain is/are involved for processing different types of meaning?

- What is the nature of the cognitive unity of speech and gesture?
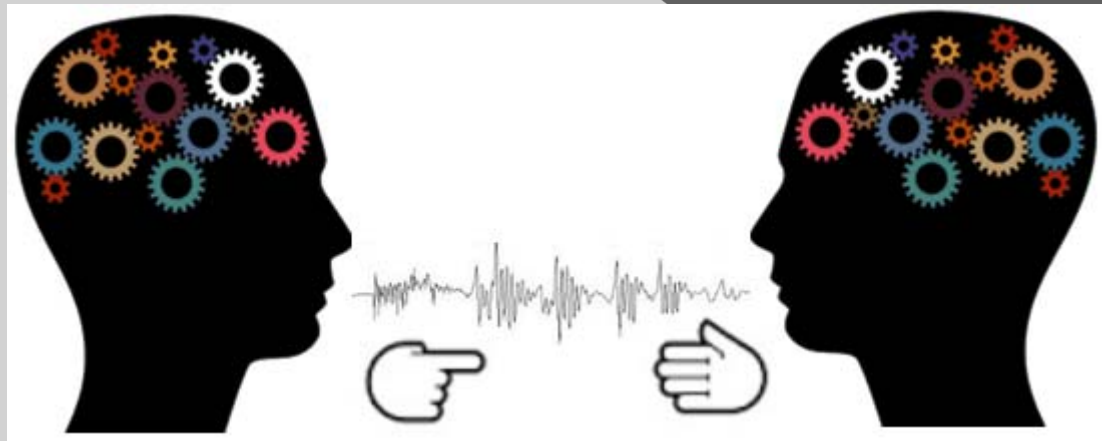
	One system or two?	Gesture types
Growth Point Theory (1992; 2000)	One system (Speech and gesture share very close temporal, semantic, pragmatic, pathological, and developmental parallels.)	iconic gestures
Lexical Gesture Process Model (2000)	Two systems that interact during formulation and articulation (Gestures facilitate lexical retrieval with higher rate of gesture per word.)	iconic gestures
Sketch Model (2000)	Two systems that interact during conceptualization (Speech and gesture maintain temporal and semantic synchrony; gesture can compensate for speaking problems.)	iconic, deictic, emblematic, pantomimic gestures
Interface Model (2003)	Two systems that interact during conceptualization and formulation (Linguistic factors like words and grammatical properties affect the production of gestures.)	iconic gestures
Gesture-As-Simulated-Action Framework (2008, 2010)	One system (Gestures, like actions, arise from embodied thinking and represent speaker's active thoughts during speaking.)	iconic gestures

What are the cognitive and neural bases for processing speech, gesture and meaning with regard to gesture types and semantic information?

THE COMPREHENSION OF DIFFERENT TYPES OF GESTURE: ERP STUDY (CHUI)
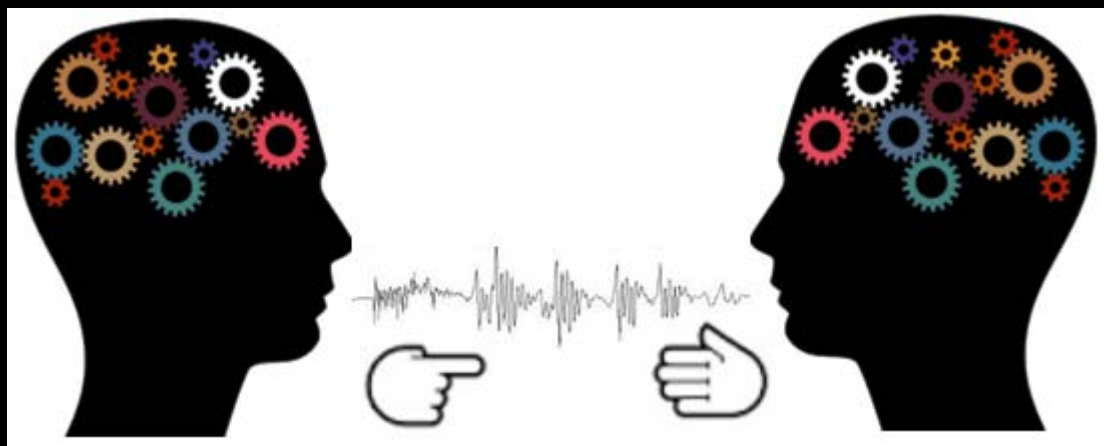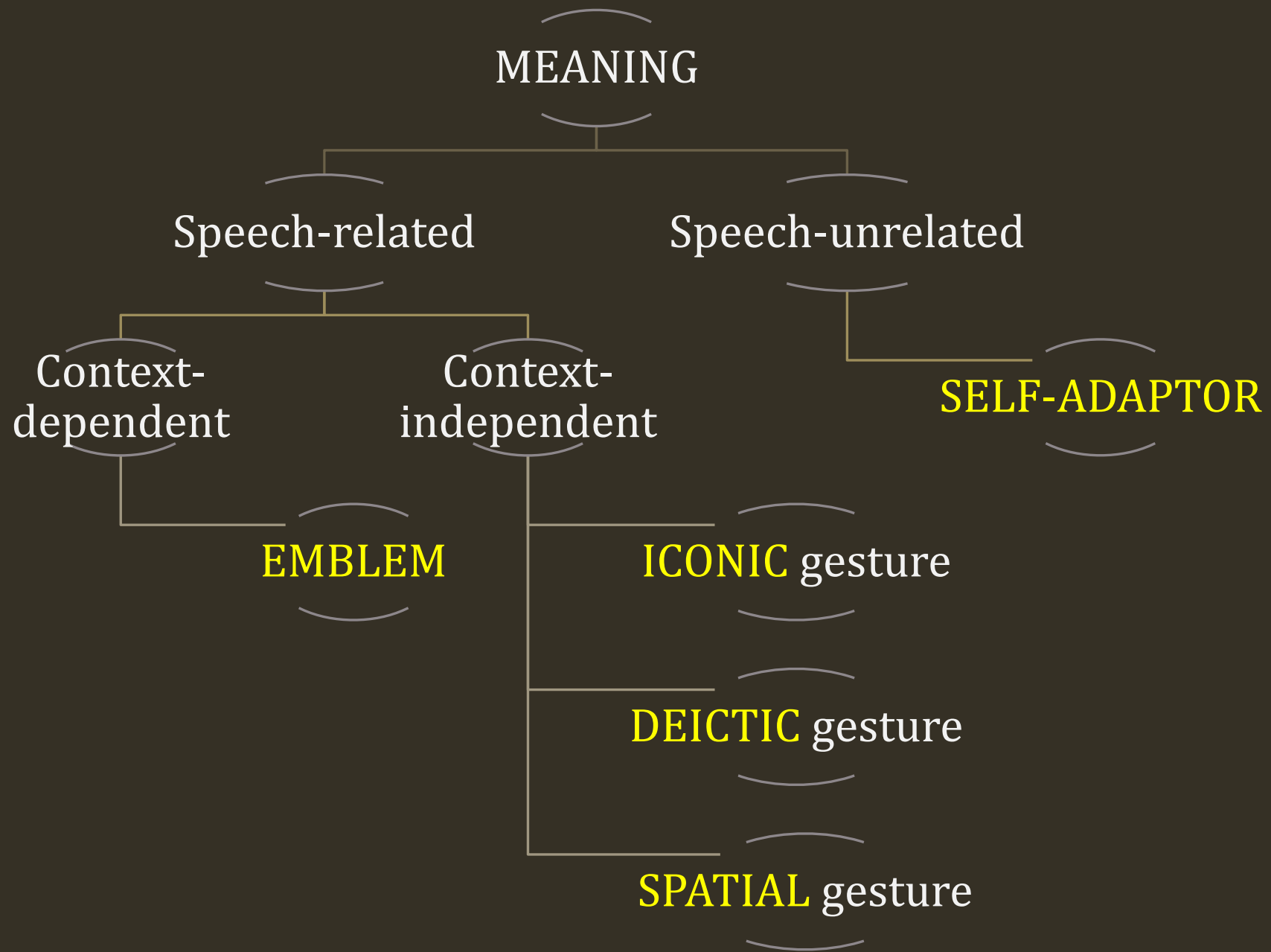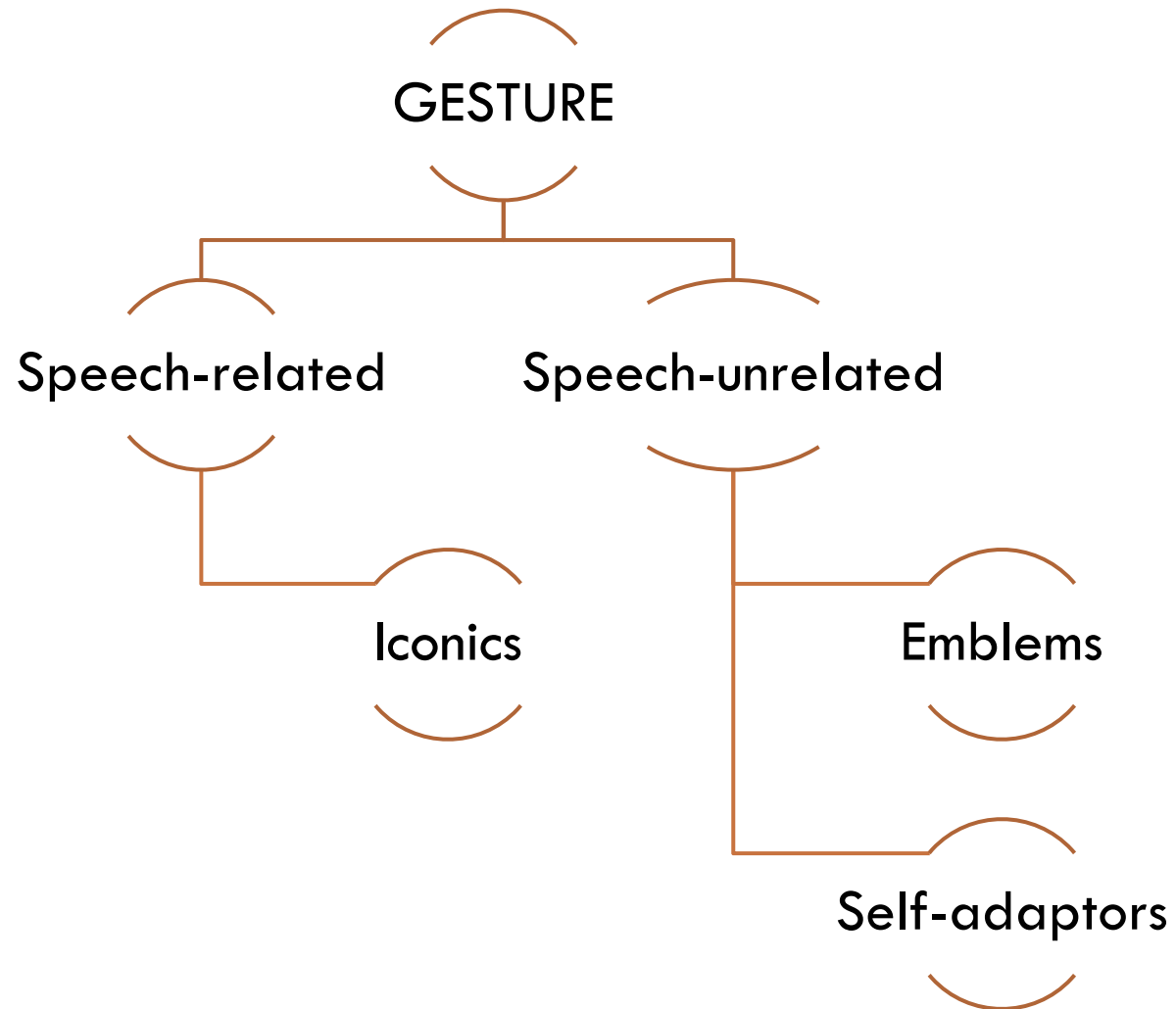
Types of gesture

| Self-adaptors | Emblems | Iconic gestures | Beat gestures | Deictic gestures | Spatial gestures |

Gesture and meaning

Research questions

- Is the processing of speech-related (emblems and iconics) and speech-unrelated meaning (self-adaptors) similar?

- Do the two types of speech-unrelated meaning have similar processing?

- How is language-gesture integration / cognitive unity affected by different types of meaning?

LINGUISTIC MATERIALS

100 disyllabic common words in clausal statements

SUBJECT	VERB	COMPLEMENT (target word)
這；那；這裡	是；有	釘子

Filler statements - 50% of the trials

☐ Fillers with different structural types of statements were used to reduce subjects' predictability during processing.

☐ 6 linguistic structures were used; animacy & transitivity were considered.

S	Vt	O	S	Vt	V	S		Vi
animate			animate			animate		
秘書	安排	行程	學者	建議	整合	遊客	隨意	拍照
S	Vt	O	S	Vt	V	S		Vi
inanimate			inanimate			inanimate		
影片	提到	歷史	劇本	獲得	欣賞	門票	即將	賣完

324 disyllabic words in fillers

A/S animate	A/S inanimate	O inanimate	Vt	Vi	Adverbs for Vi
民眾	題目	路況	配合	散步	一起
記者	門票	台詞	提出	賣完	十分
歌手	河流	拼圖	介紹	發芽	剛好
54	54	36	72	72	36

Comprehension questions

- There were comprehension questions after some randomly-selected trials to ensure subjects' attention.

- Each question was about the content of the video just being viewed.

- Three answers for each question were provided.

- The participant then chose an answer by pressing a corresponding number on the keypad.

GESTURAL MATERIALS

Video clips

- Short videos displaying statements with or without gestures were used in the experiment.

- The speaker and addressee were situated in a setting that resembled very much the daily face-to-face interactional environment with the addressee acknowledging the speaker's utterance by nodding one time, so that the results could reveal people's more natural and realistic semantic processing of speech and gesture.

Speech-only condition

□ Statements are presented by speech without gesture. The actress puts her hands on her lap during speaking.

Iconic-gesture condition

- An iconic gesture is performed along with speech.

Emblematic-gesture condition

- An emblematic gesture is performed along with speech.

Self-adaptor condition

□ A self-touching gesture is performed along with speech.

800 video clips

	Experimental trials	Fillers
Speech-only condition	100	100
Iconic-gesture condition	100	100
Emblematic-gesture condition	100	100
Self-adaptor condition	100	100

STIMULI VALIDATION

Validation

- The video stimuli including speech and gestures were validated.

- Each one was rated by 20 undergraduates who did not participate in the experiment.

- Practice trials were provided, after which the participants rated the semantic relationship between speech and gesture on a scale from 1 to 5: '1' is the lowest degree of relatedness and '5' is the highest.
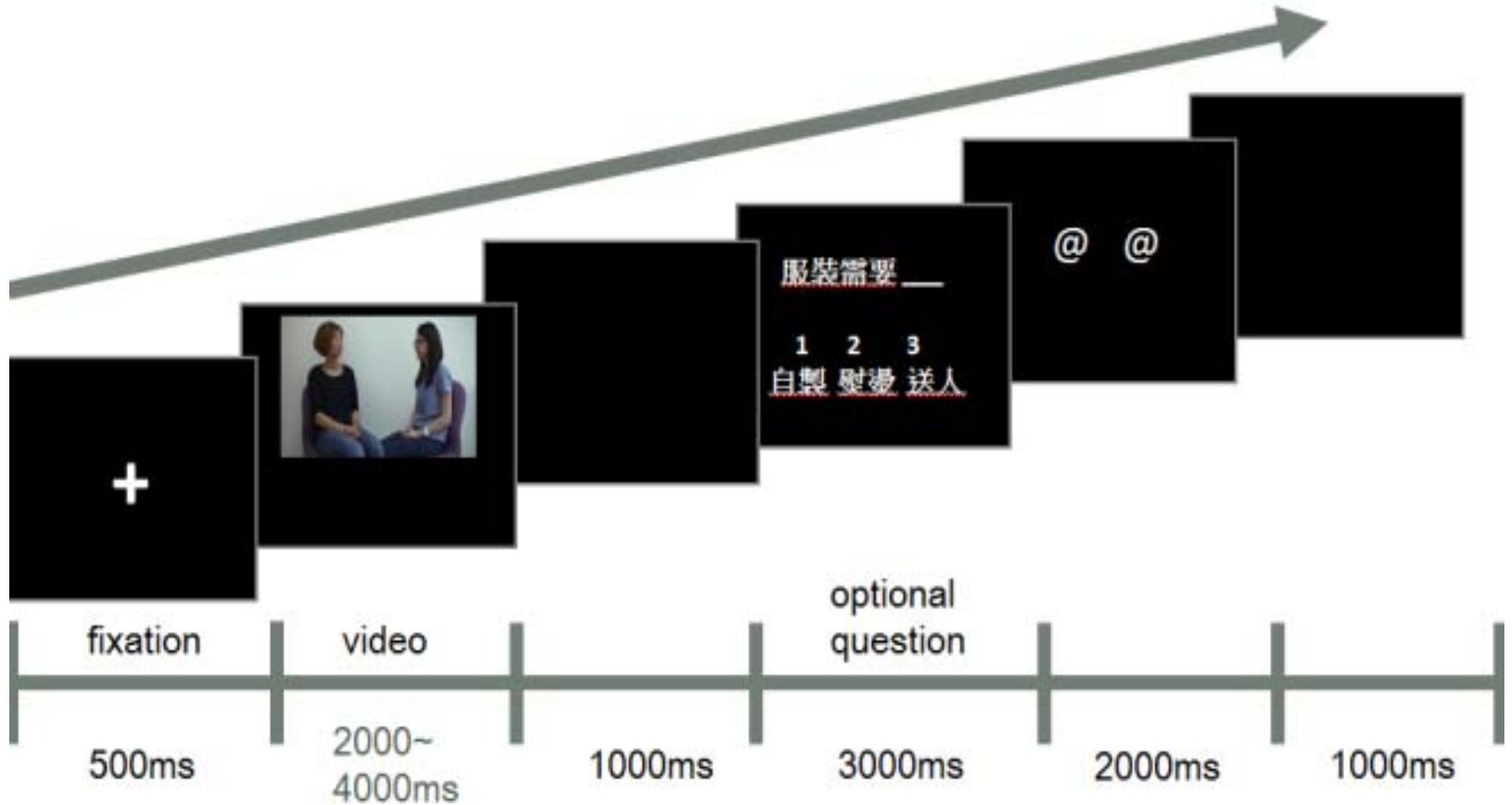
Rating results

非常高	高	中	低	非常低
5	4	3	2	1
Iconics (4.3)			Emblems (1.2) Self-adaptors (1.1)	

Experimental trials

	Experimental trials	Fillers
Speech-only condition	21	84
Iconic-gesture condition	21	
Emblematic-gesture condition	21	
Self-adaptor condition	21	

Programming the experiment

fixation — 500ms

video — 2000~4000ms

1000ms

optional question — 3000ms

2000ms

1000ms

服裝需要 ___

1 **2** **3**
自製 熨燙 送人

@ @

Subjects

Some results

MAIN EFFECT ON GESTURE AND ANTERIORITY

Gesture* Anteriority

- Adaptor-Speech (F,FC,C,CP,P)
- Iconic–Speech (FC,C,CP,P)
- Emblem-Speech (FC)
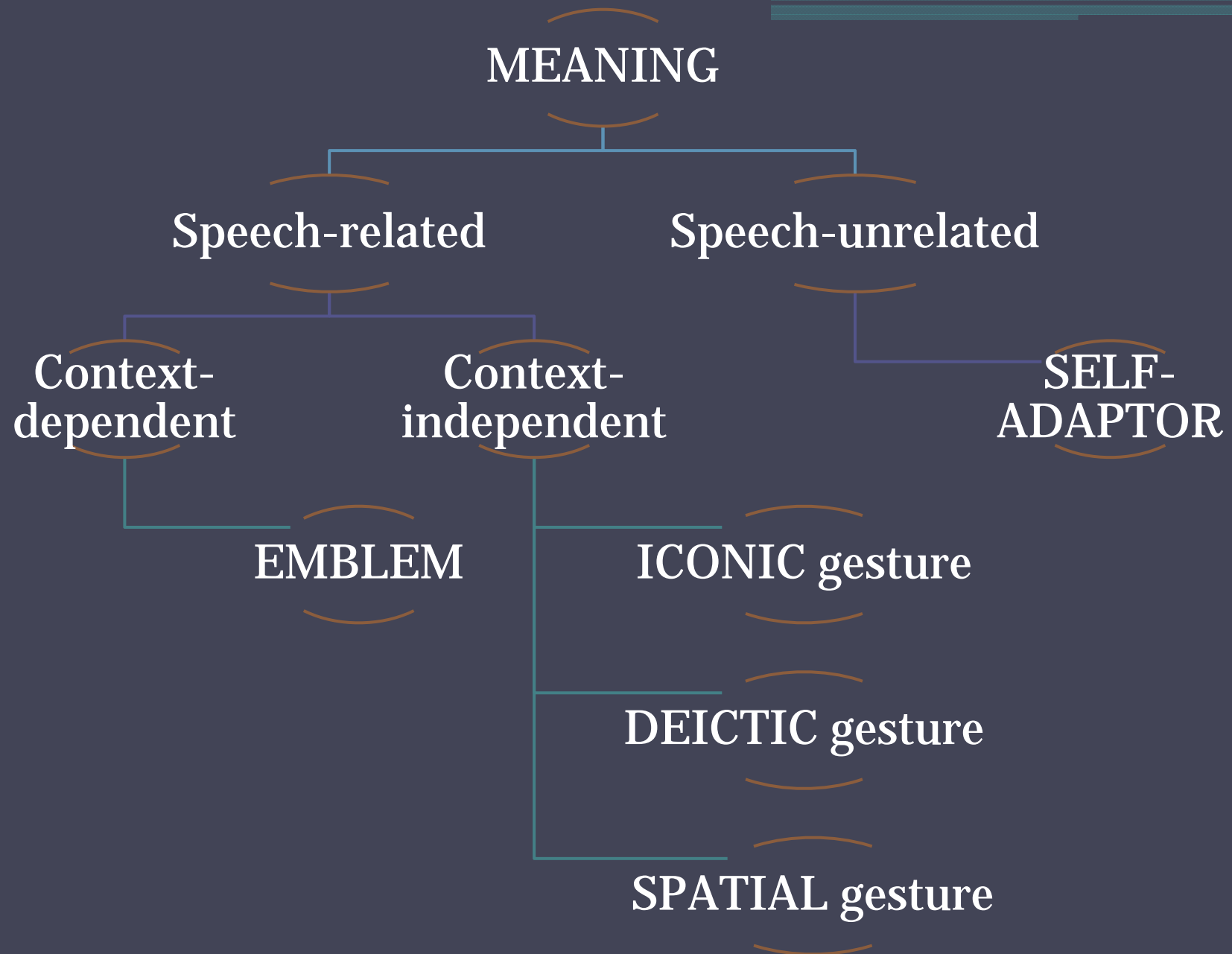- Adaptor- Iconic (F,FC,C,CP,P)
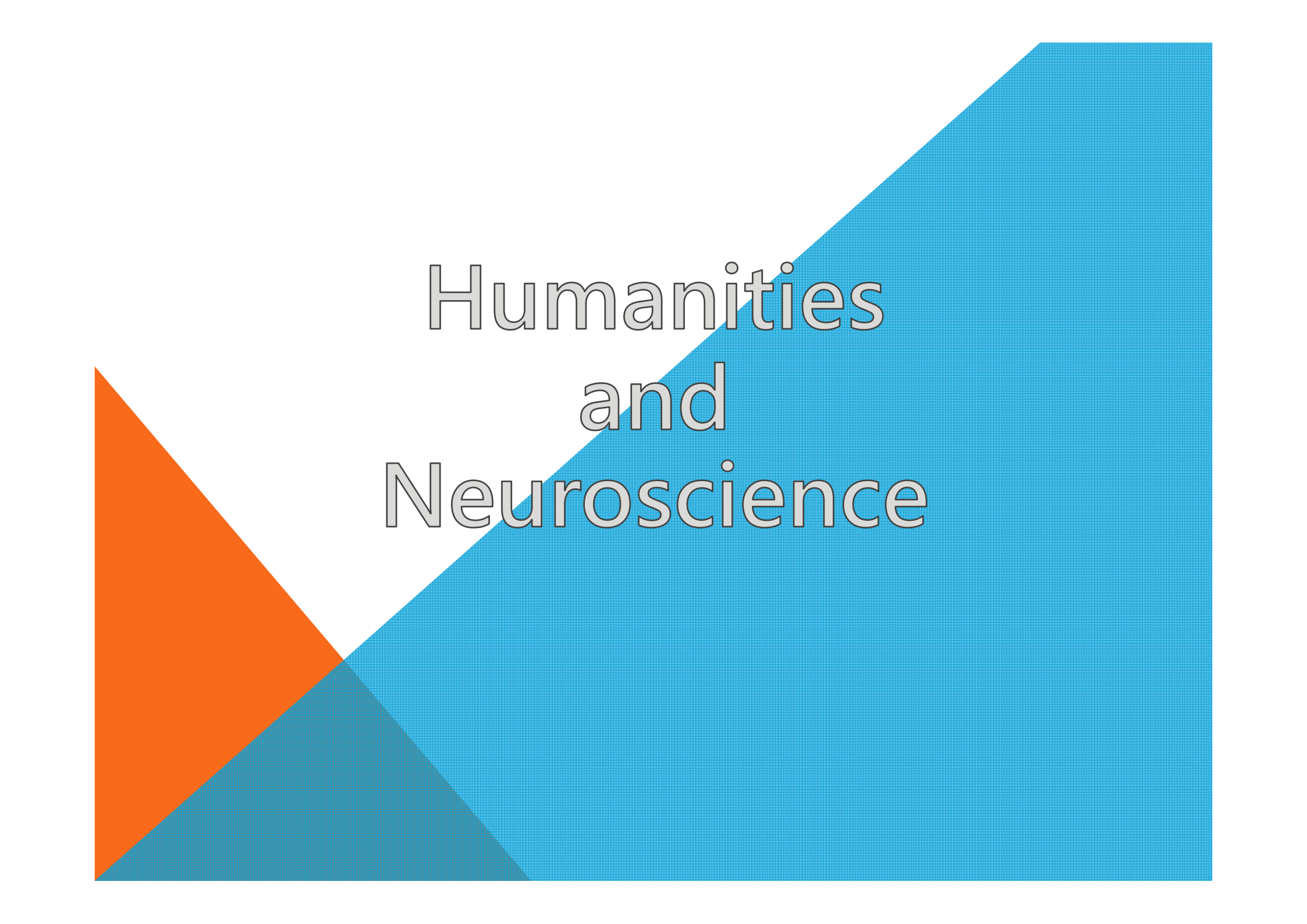- Emblem-iconic (F,FC,C,CP,P)

MAIN EFFECT ON GESTURE AND LATERALITY

Gesture* Laterality

- Adaptor-Speech (x3,x1,xZ,x2,x4)
- Iconic–Speech (x1,xZ,x2,x4)
- Emblem-Speech (x3,x1)
- Adaptor- Iconic (x3,x1,xZ,x2,x4)
- Emblem-iconic (x3,x1,xZ,x2)

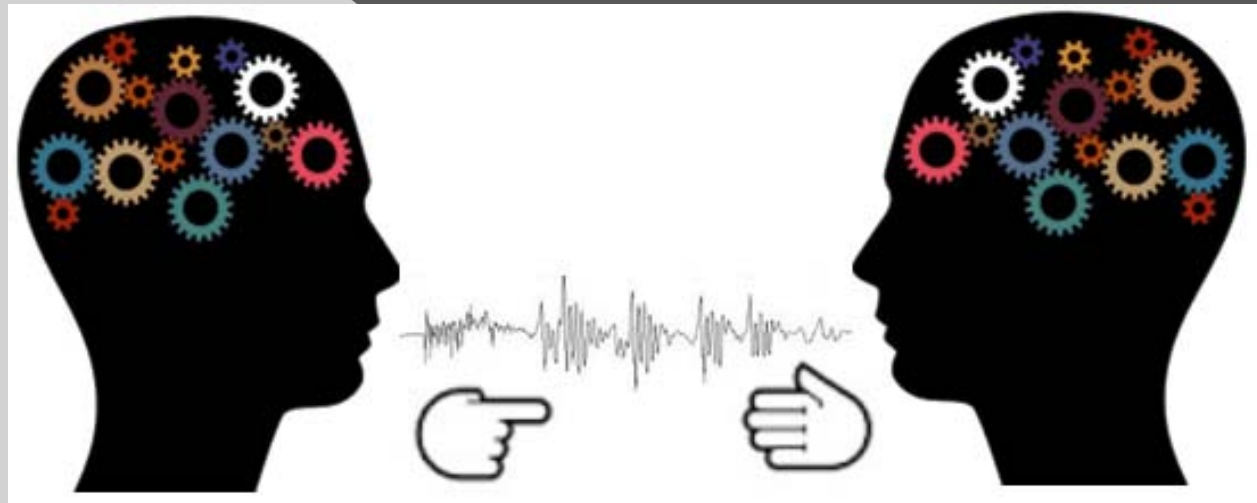# SEMANTIC PROCESSING OF LINGUISTIC-GESTURAL INFORMATION: FMRI STUDY

Humanities and Neuroscience

CHALLENGES

COLLABORATION

THANK YOU!