Neuro-cognitive demands of foreign language communication in disaster situations

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At a time of …

international conflict

climate crisis

migration

pandemic

… international action and collaboration crucial

… cannot happen without people being able to communicate in a second language in crisis settings.

Joint statement (2020):

“During a global health crisis, researchers, governments, and health care workers must be able to share accurate information. In such times, language matters, and fluency in our languages matters. The people of the world must be able to speak to each other and be understood—to communicate as effectively and as rapidly as technology allows.”

The British Academy

AMERICAN ACADEMY OF ARTS & SCIENCES

Australian Academy of the Humanities

ACADEMY OF THE SOCIAL SCIENCES IN AUSTRALIA

RSC SRC
The Royal Society of Canada
The Academies of Arts, Humanities and Sciences of Canada
La Société royale du Canada
Les Académies des arts, des lettres et des sciences du Canada

SENDAI FRAMEWORK
FOR DISASTER RISK REDUCTION 2015-2030

It is important to invest in, maintain, and develop
emergency communication mechanisms

Involves communicating in multiple languages

Recommendation from Word Health Organisation project to improve protocols for disaster communication (Medard-Davis & Kapus, 2014) :

Important to prepare for emergencies **through simulation in a rapidly evolving high stress environment**

Involves simulating communication in second/foreign languages

Despite the importance of being able to communicate in a second language in crisis situations, little research on second language communication in critical situations.

To promote the success of international communication in disaster situations,

it is essential to develop appropriate **second language (L2) teaching methods**, **materials**, and **assessments**.

Task-based language teaching appears promising to reach this objective

Task-based language teaching aims to prepare learners to carry out **genuine communicative tasks** aligned with their future academic, professional, and/or personal needs.

For disaster/crisis situations: prepare L2 learners to communicate in specific crisis situations

In task-based language teaching, this is achieved by taking **task**, instead of linguistic units (grammar or vocabulary) as the main unit of language teaching.

Examples for tasks:

- Making a decision about vaccine allocation under pressure
- Communicating evacuation plans
- Deciding an emergency strategy as part of an international group
- Determining what actions to take in an international rescue team

Task-based language teaching aligned with notion of **transfer-appropriate processing** from cognitive psychology:

We can better transfer and "remember what we have learned if the **cognitive processes that are active during learning** are **similar to those that are active during retrieval**" (Lightbown, 2007, p. 27).

Implication for crisis settings:
learners need to practice using second language in crisis situations

Parallel to WHO project recommendation: important to prepare for emergencies through simulation in high stress environment

Growing amount of research on task-based language teaching,

but

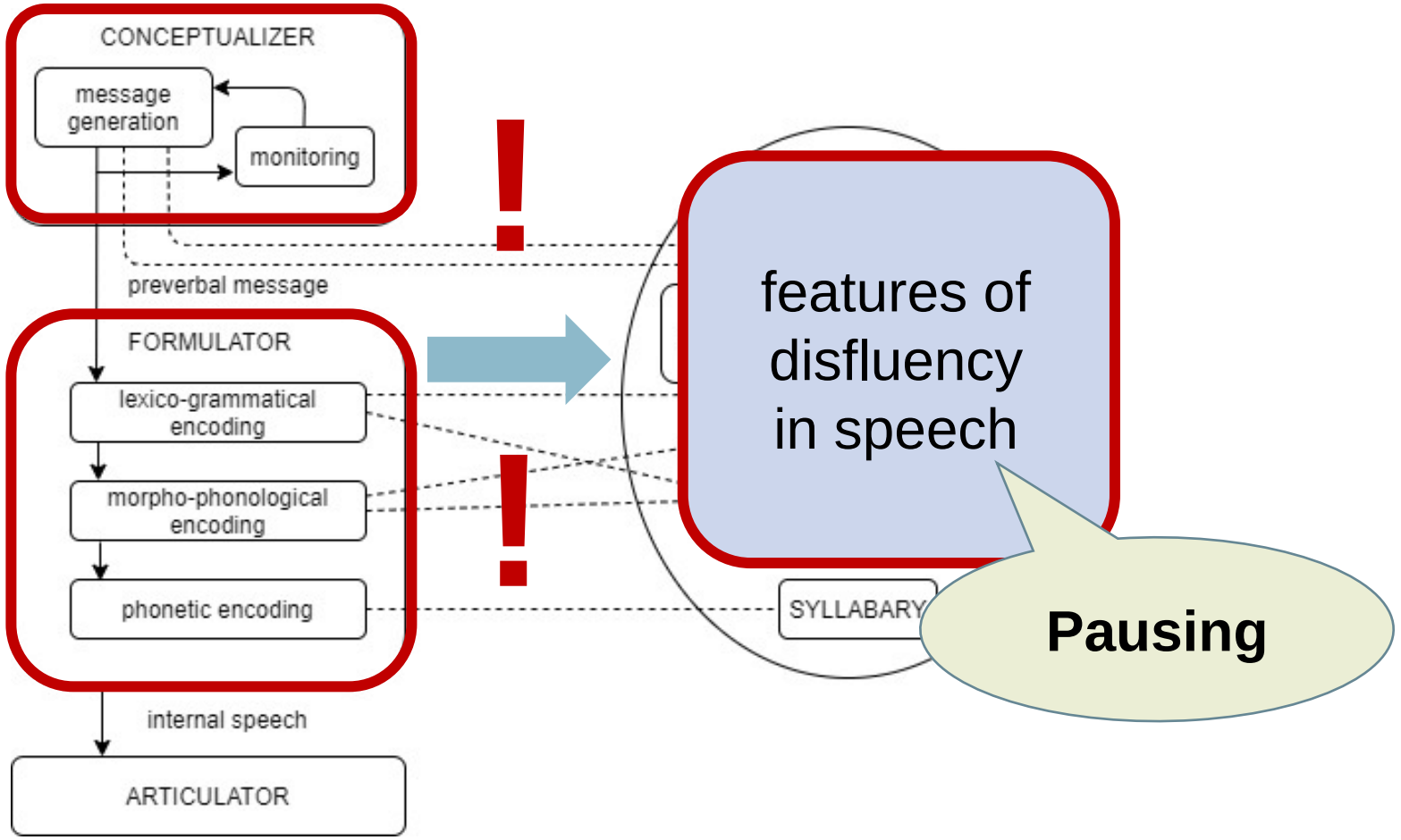
little known about the processes underlying task-based performance, let alone

- in crisis situations
- using neuroimaging methods

To fully understand L2 production processes and to draw sound implications for teaching, it is vital to obtain evidence about both cognitive and neural L2 processes (behavioural data may mask differences)

Broad project aim: investigate the **cortical mechanisms** involved in **oral production** during **decision-making tasks in crises**.

Background: Speech production



Kormos (2006), Levelt et al. (1999)

End-clauses versus mid-clauses

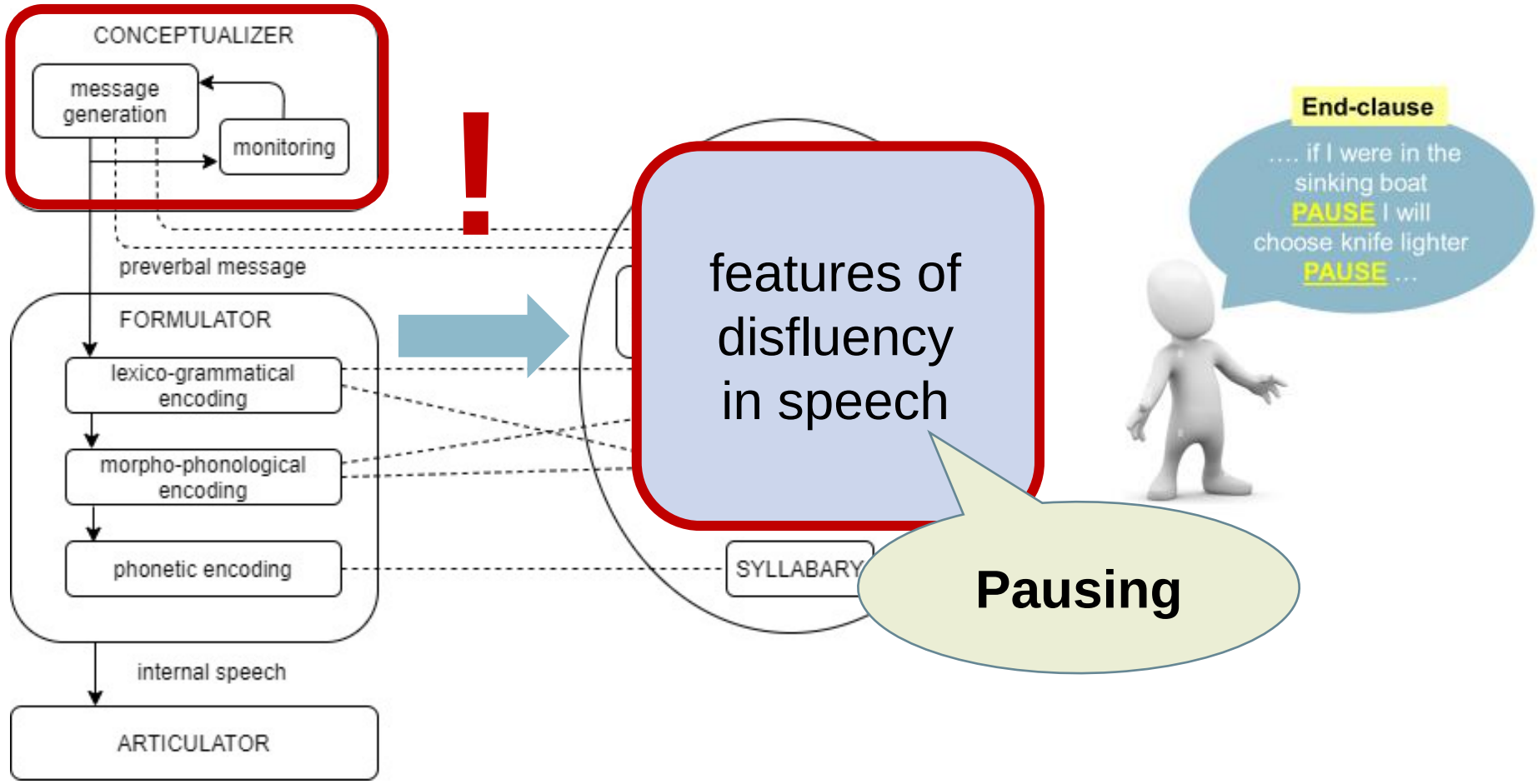
End-clause

…. if I were in the sinking boat **PAUSE** I will choose knife lighter **PAUSE** …

Mid-clause

…. if I were in the sinking **PAUSE** boat I will choose knife **PAUSE** knife lighter …

Background: Speech production



De Jong (2016); Rizantseva (2001)

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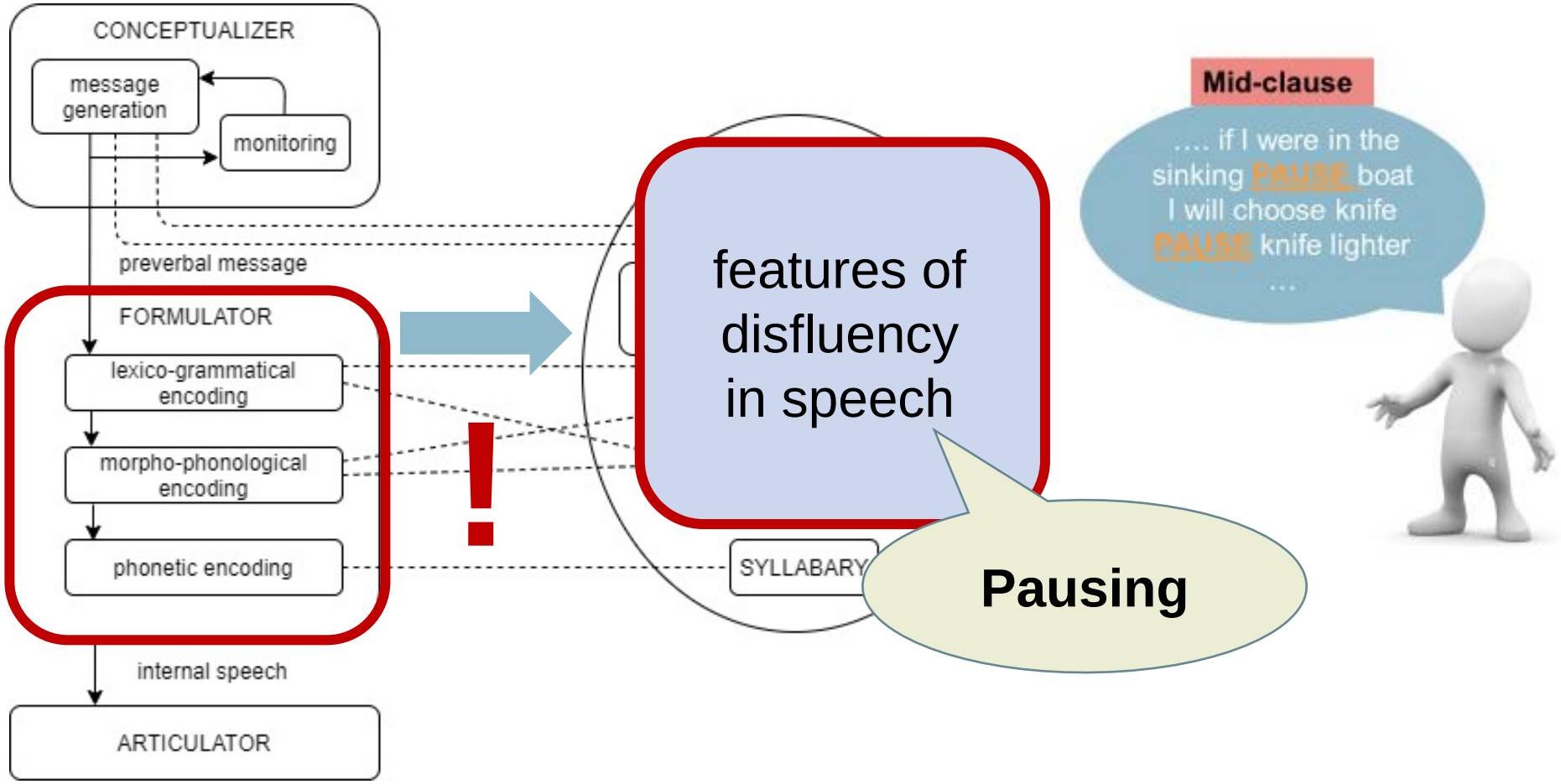


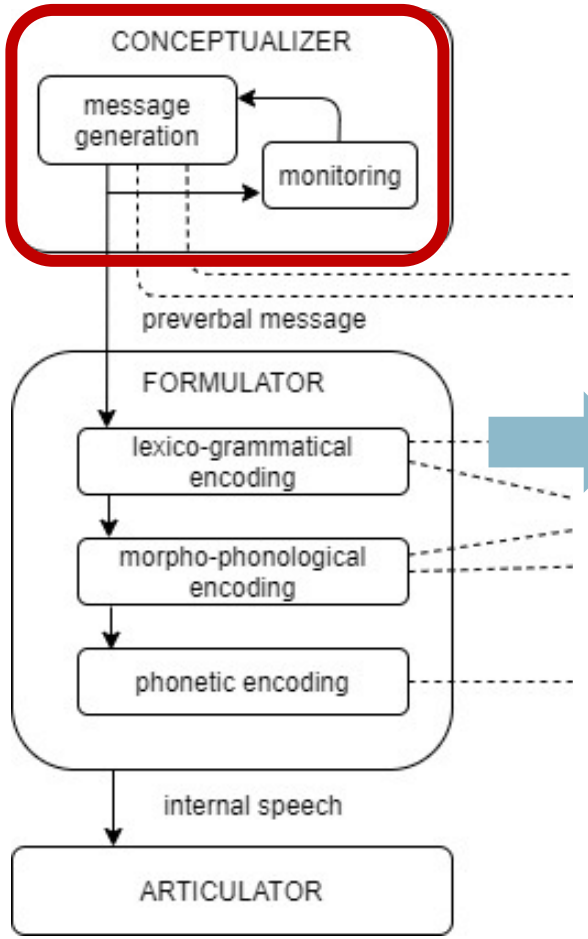
Kormos (2006), Levelt et al. (1999)

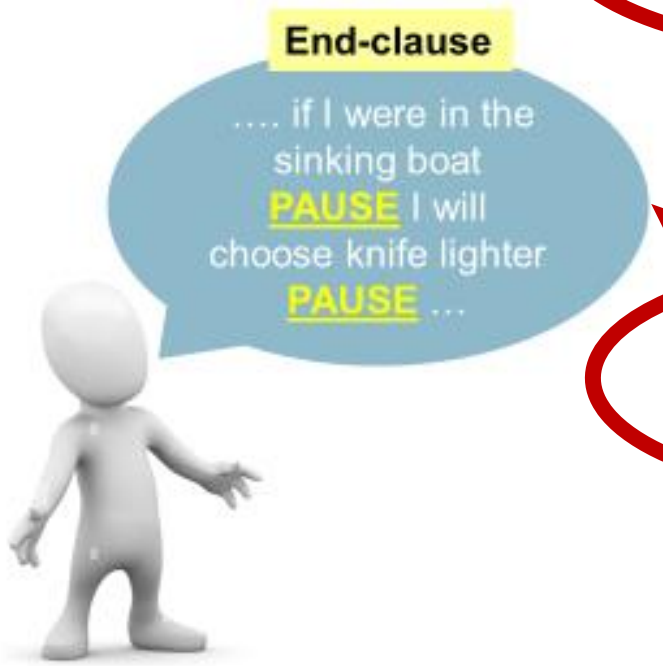
Specific aims

- **Aim:** to examine the neural correlates of silent pausing during crisis-related decision-making tasks
- Effects of **first language** versus **second language**
- **Cognitive demands** of disaster-related decision-making tasks

Hypotheses: Language effects

Same in first and second language





behavioural

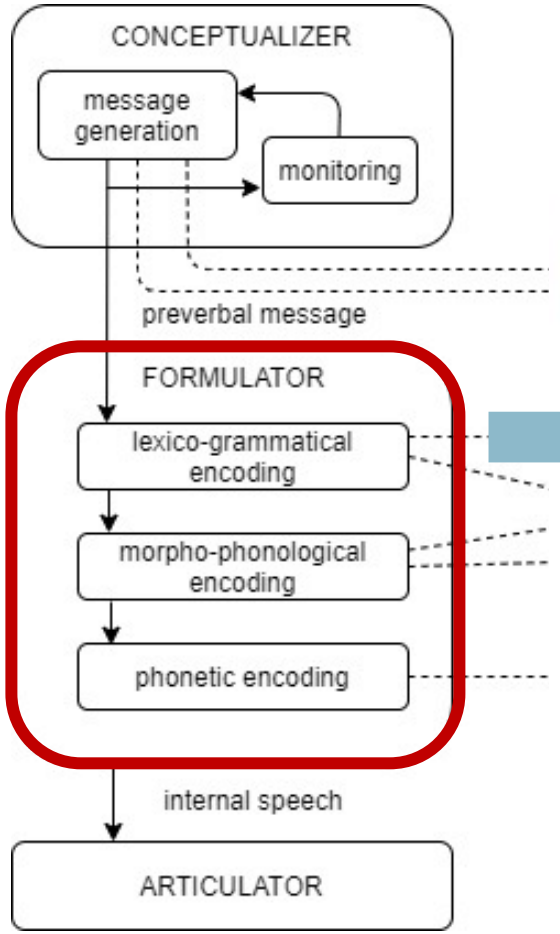
No language effects on end-clause pausing

neural

No language effects on neural activity

De Jong (2016); Rizantseva (2001)

Hypotheses: Language effects



More challenging in second than first language

Mid-clause

…. if I were in the sinking PAUSE boat I will choose knife PAUSE knife lighter …

behavioural

In second language: more and longer mid-clauses

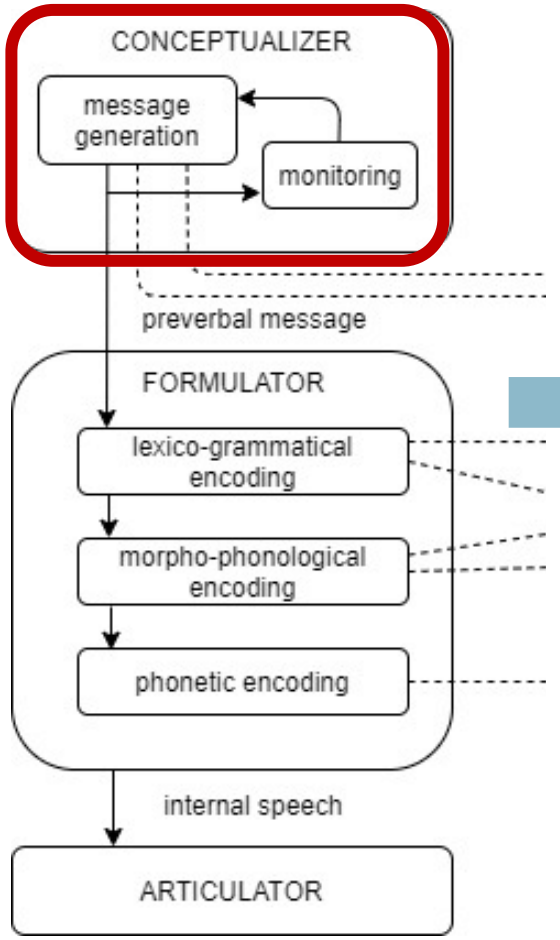
neural

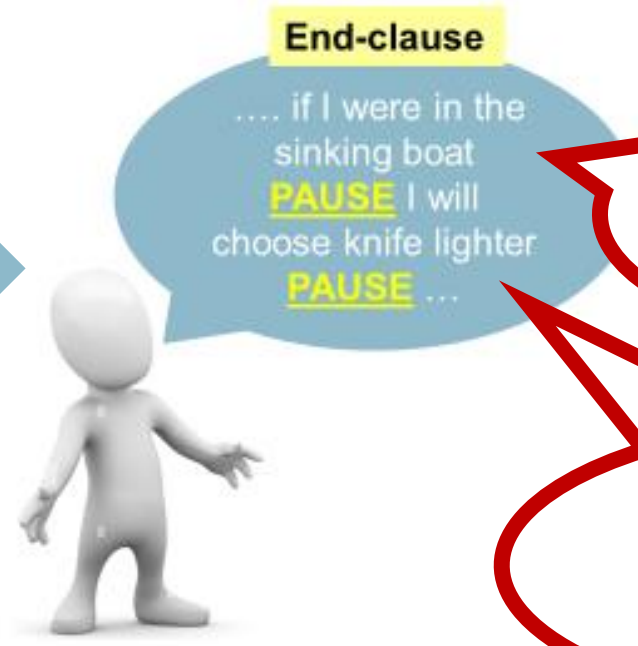
In second language: greater neural activity in language-related brain areas

De Jong (2016); Rizantseva (2001)

Hypotheses: Cognitive task demands

Greater pressure during more demanding tasks





behavioural

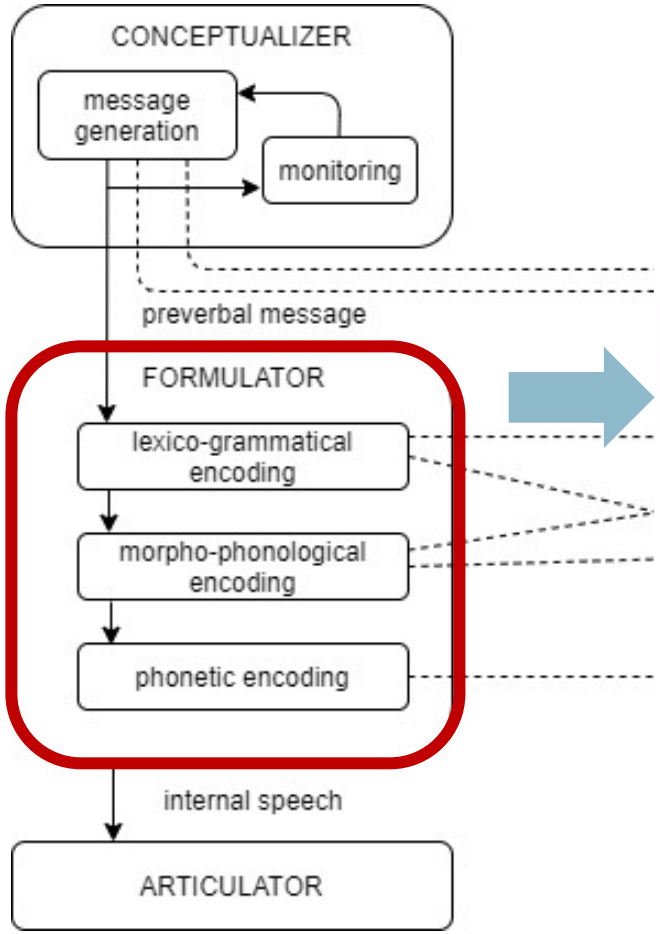
More demanding task: more and longer end-clauses

neural

More demanding task: greater neural activity in conceptualisation-related brain areas

Hypotheses: Cognitive task demands

Greater pressure during more demanding tasks in second language



behavioural

More demanding tasks: more and longer mid-clauses in second language

neural

More demanding tasks: greater neural activity in language brain areas in second language

Methodology: Participants

- 26 Japanese learners of L2 English recruited, 20 in final dataset (6 excluded due to audio quality and head movement)
- University students

Methodology: Experimental Design

Task
1. Desert Island
2. Parachute
3. Earthquake
4. Vaccination
5. Flooding
6. Fire
7. Plane Crash
8. New Virus

- 8 monologic speaking tasks
- Disaster-related decision-making tasks

FLOODING

You have just received a flooding alert! You need to leave by car. It takes three hours to drive to the emergency accommodation. Choose **four items** from the list to take with you. **Explain why you chose or did not choose each item**.

Family photographs

Bottled water

Credit card

Rice cakes

Laptop

Gasoline

Mobile phone

Medicine

VACCINATION

You work for a COVID-vaccination center. You have five vaccines left. You need to use these five vaccines by the end of the day. A snowstorm hit, so nobody can get to the center any longer. There is a bus stuck nearby with eight passengers. Choose **five passengers** to get the vaccinations. **Explain why you chose or did not choose each person**.

Make-up artist

Doctor

Ballet dancer

Policeman

Nurse

Comedian

Teacher

Dentist

Methodology: Experimental Design

Task	Language
1. Desert Island	L2 English
2. Parachute	
3. Earthquake	
4. Vaccination	
5. Flooding	L1 Japanese
6. Fire	
7. Plane Crash	
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- 8 monologic speaking tasks
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Methodology: Experimental Design

Task	Language	Complexity
1. Desert Island	L2 English	Simple
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Bottle of wine

Bottled water


Credit card


Rice cakes


Headphones


Coffeemaker


Mobile phone


Favourite book

Simple

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Family photographs

Bottled water


Credit card


Rice cakes


Laptop


Gasoline


Mobile phone


Medicine

Complex

Less reasoning, less complex decision-making process < **More reasoning, more complex decision-making process**

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Truck driver


Doctor


Firefighter


Policeman


Nurse


Shop assistant


Teacher


Dentist

Complex

Less reasoning, less complex decision-making process < **More reasoning, more complex decision-making process**

Methodology: Experimental Design

Task	Language	Complexity
1. Desert Island	L2 English	Simple
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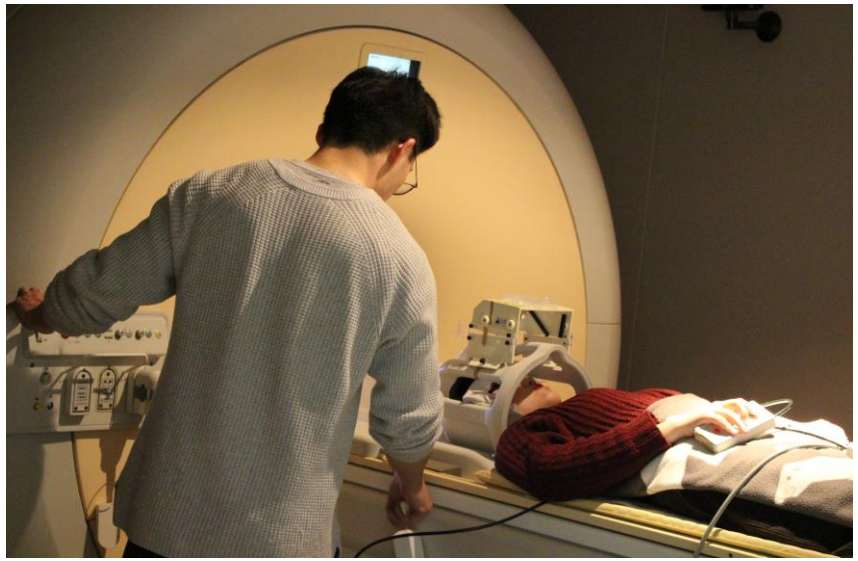
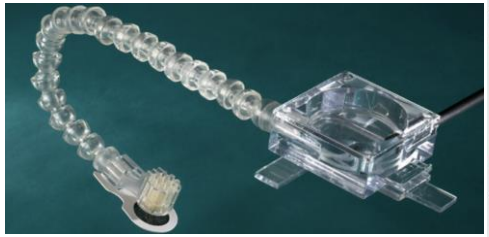
7. Plane Crash		Complex
8. New Virus		

- 8 monologic speaking tasks
- Disaster-related decision-making tasks
- Task, language, and task complexity counter-balanced across participants

Methodology: Procedures

- fMRI scanning: 3T MRI Philips achieva
- MRI compatible noise cancelling microphone
- Repetition of scan time: 2 seconds





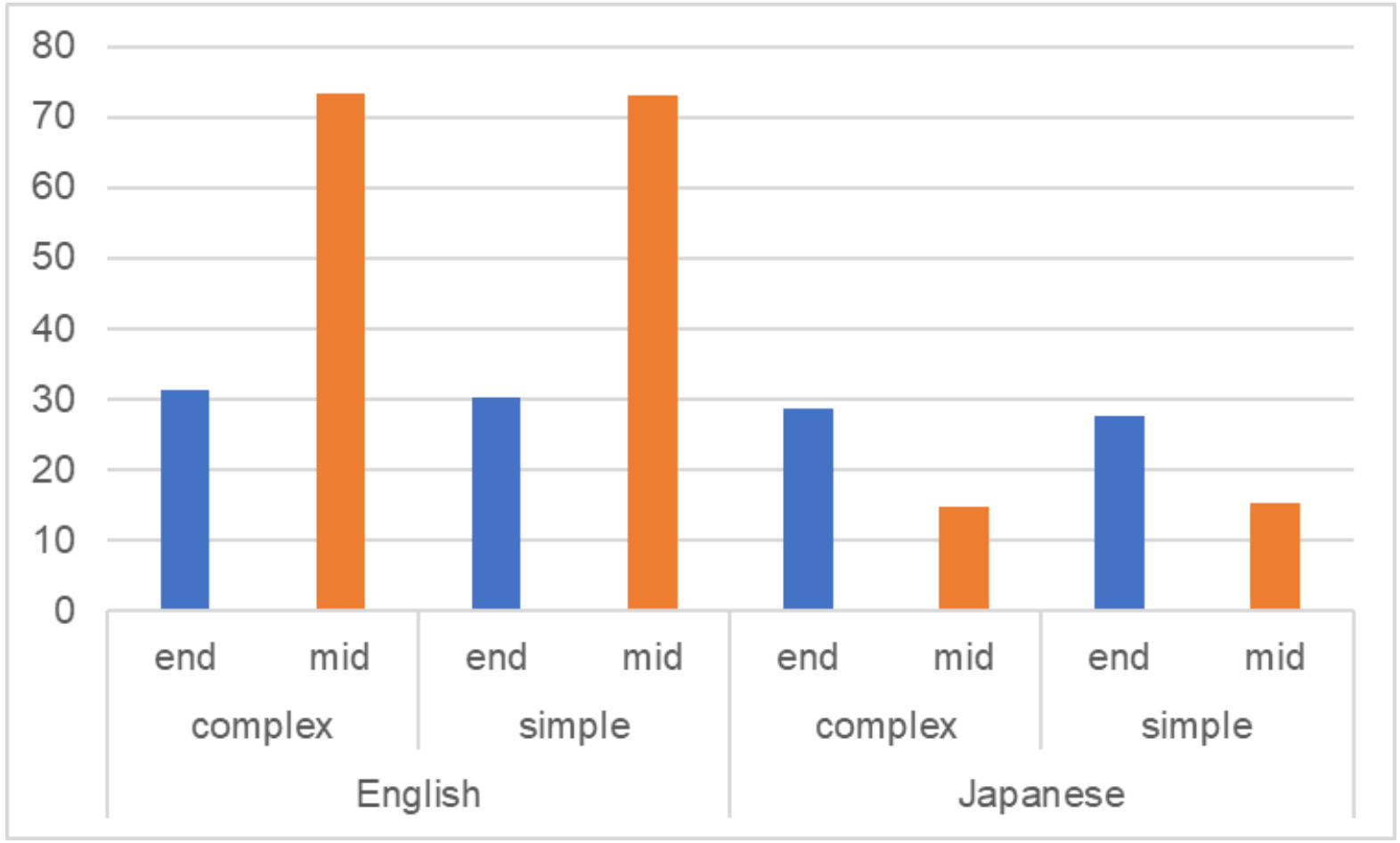
No noise reduction

Noise reduction

Methodology: Data analyses

- 160 performance transcribed and coded by one of the researchers using PRAAT (Boersma & Weenink, 2007)
  - L2 English performance (4 tasks x 20 participants)
  - L1 Japanese performance (4 tasks x 20 participants)

Behavioural results: Pause frequency

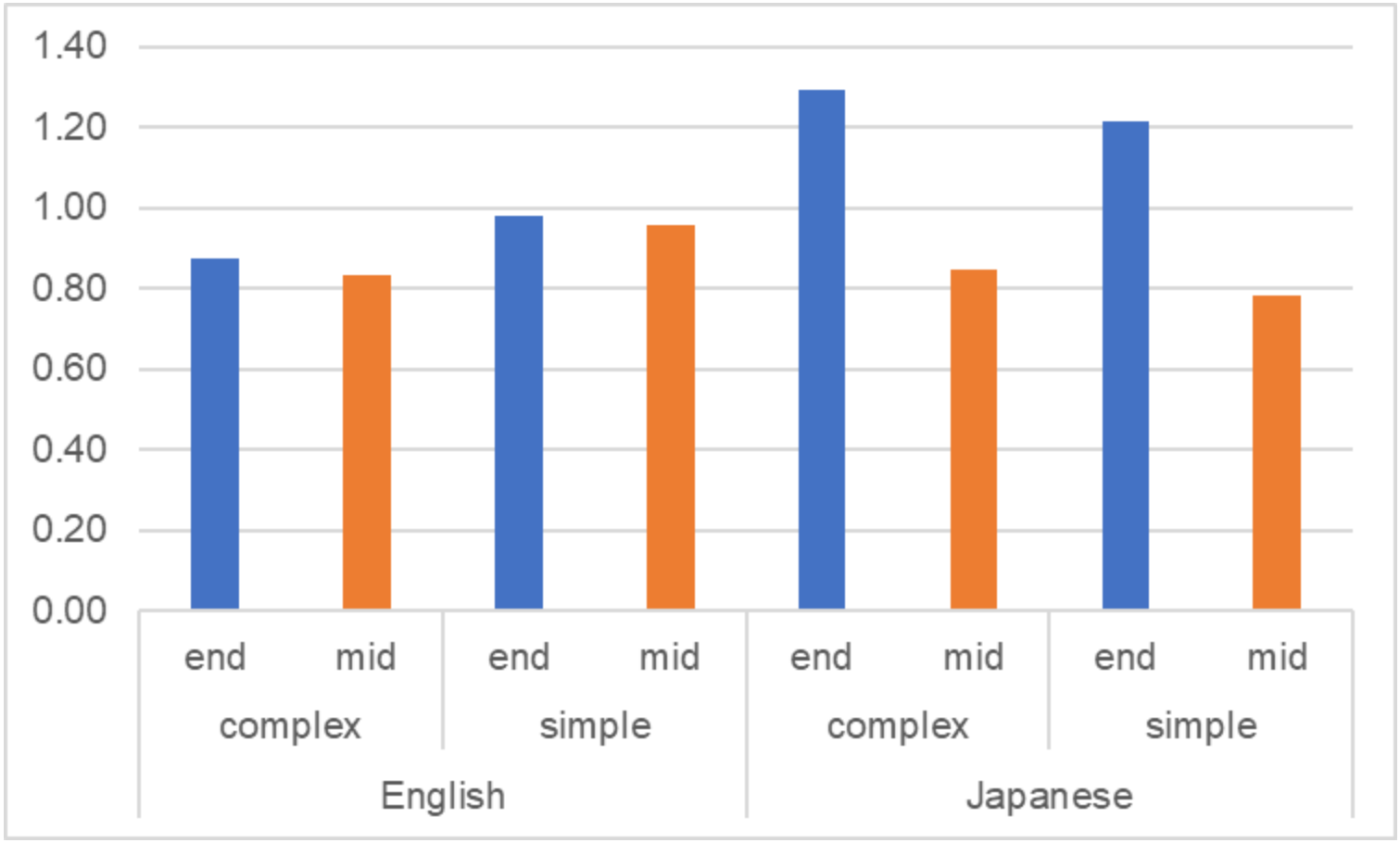


Mid-clause pauses:
L2 English > L1 Japanese

No task effects

Mixed effects regression model:
Sig interaction between language and pause location

Behavioural results: Pause length



Mid-clause < End-clause

No sig language effects

No task effects

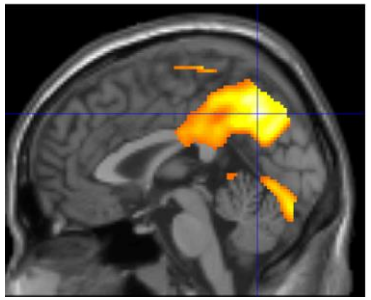
Mixed effects regression model:
Significant effect for pause location

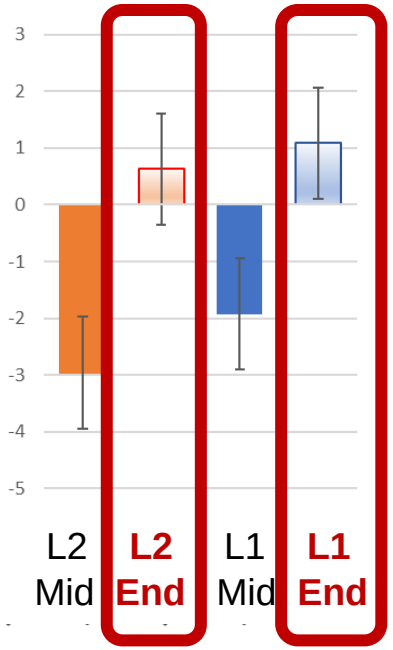
fMRI results: Language effects

Region of interest analyses:

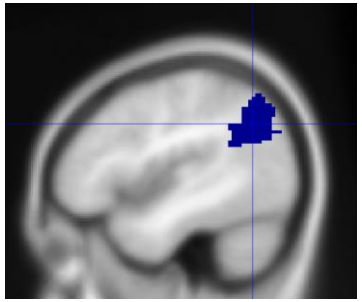
- **Interaction effect between language and pause location**

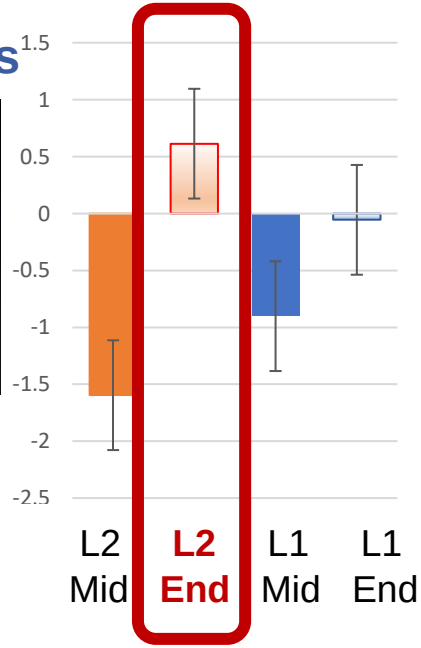
precuneus





left angular gyrus





L1/L2 end-clause pausing: greater activation in **conceptualisation-related area** (theory-of-mind area)

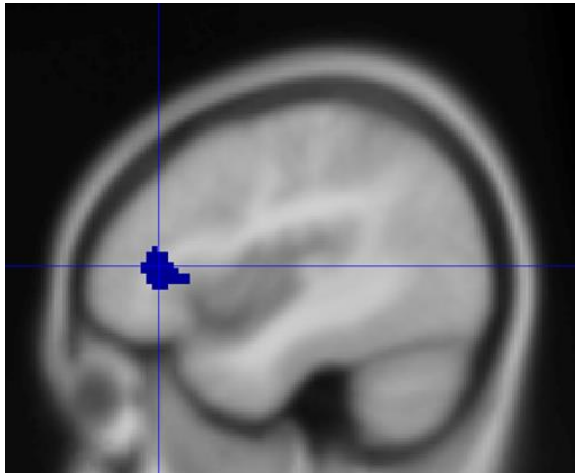
L2 end-clause pausing only: greater activation in **conceptualisation-related area** (concept retrieval)

fMRI results: Language effects

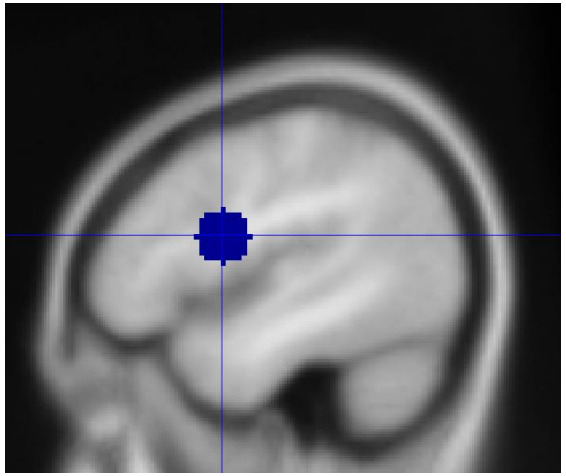
Region of interest analyses:

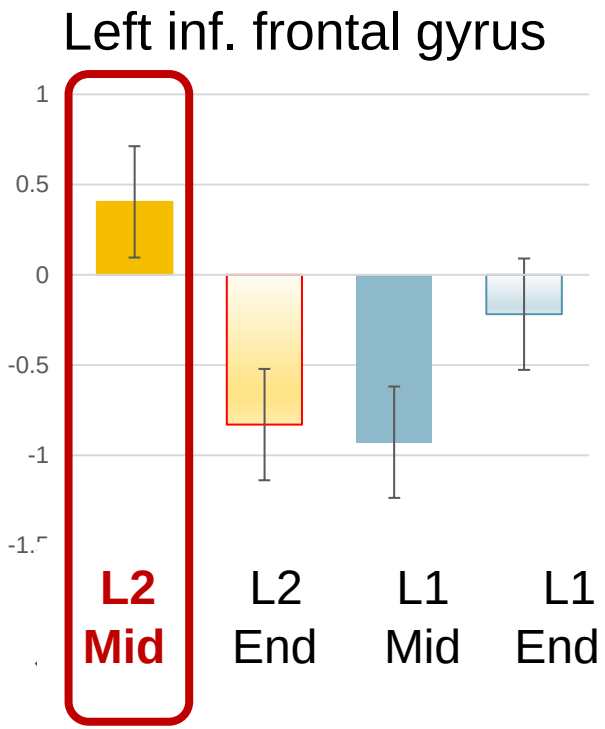
- **Interaction effect between language and pause location**

Left triangular part of inferior frontal gyrus (BA45)



Left opercular part of inferior frontal gyrus (BA44)





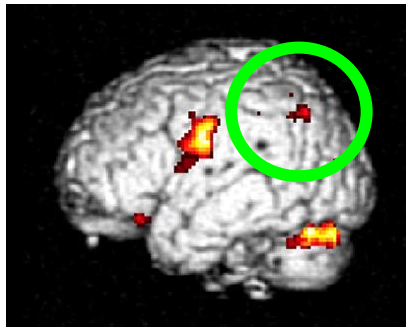
L2 mid-clause pausing**:** greater activation in **language-related areas** (sentence construction, vocabulary selection)

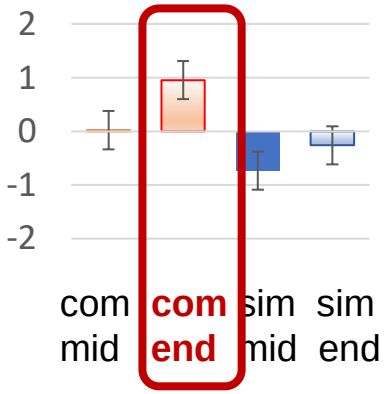
$F(1,19)=4.50$, $p<0.05$, $F(1,19)=16.34$, $p<0.001$

fMRI results: Task effects

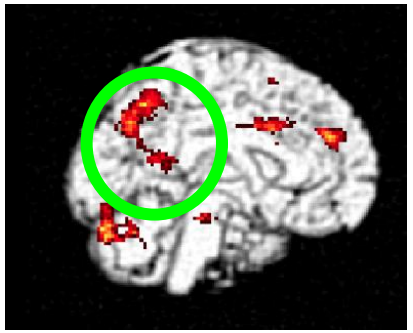
L2 English

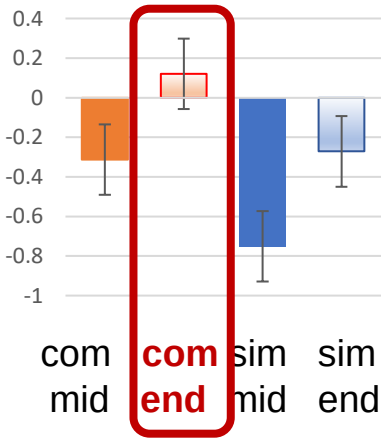
left angular gyrus





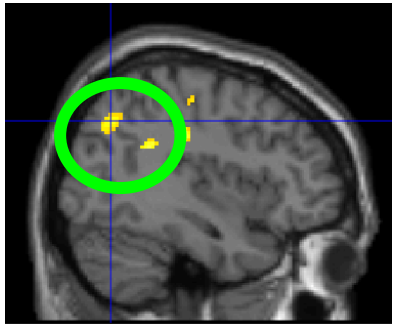
precuneus

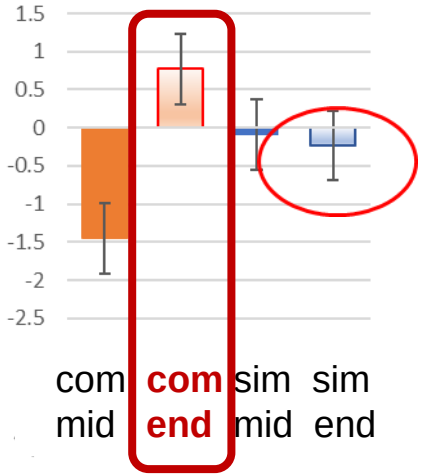




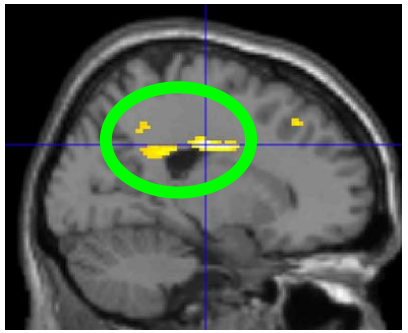
L1 Japanese

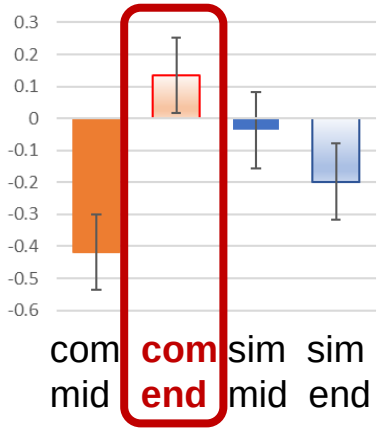
right angular gyrus





posterior cingulate cortex



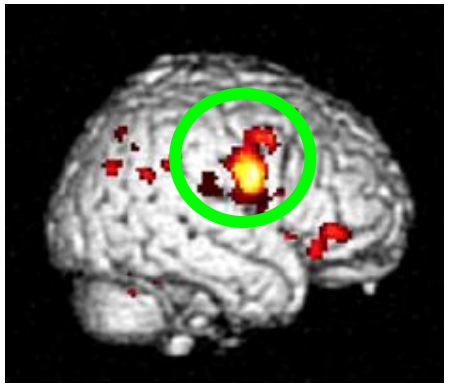


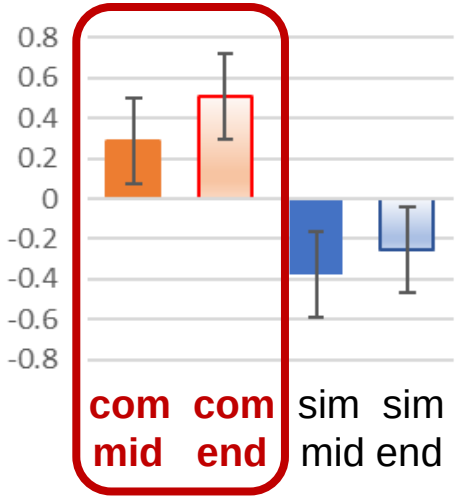
End-clause (L1, L2) pausing **more complex task**: greater activation in areas related to **conceptualization** (theory-of-mind network)

fMRI results: Task effects

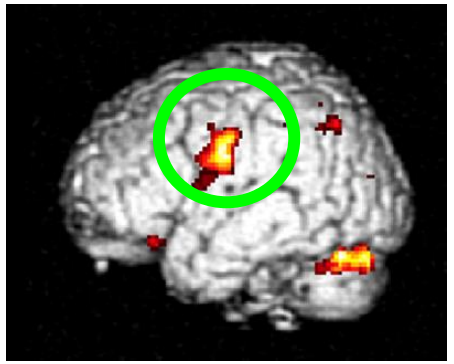
L2 English

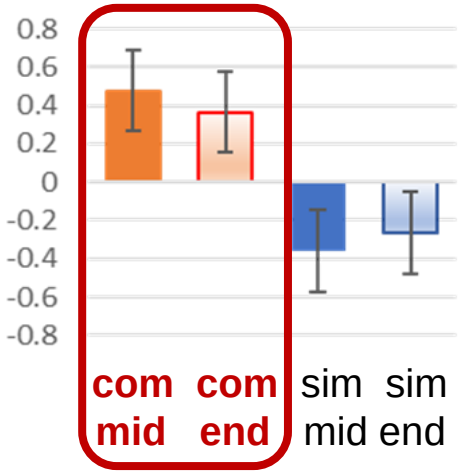
right precentral gyrus





left precentral gyrus

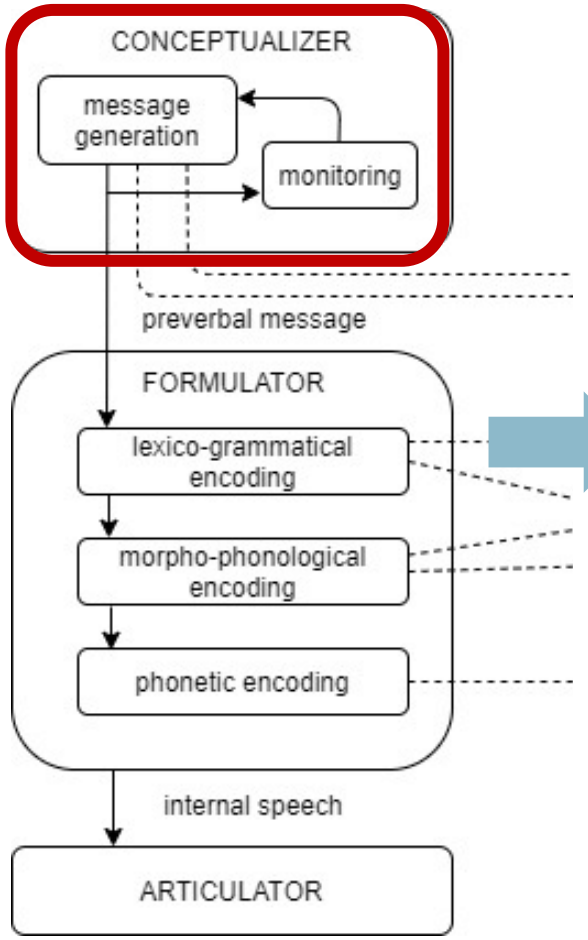


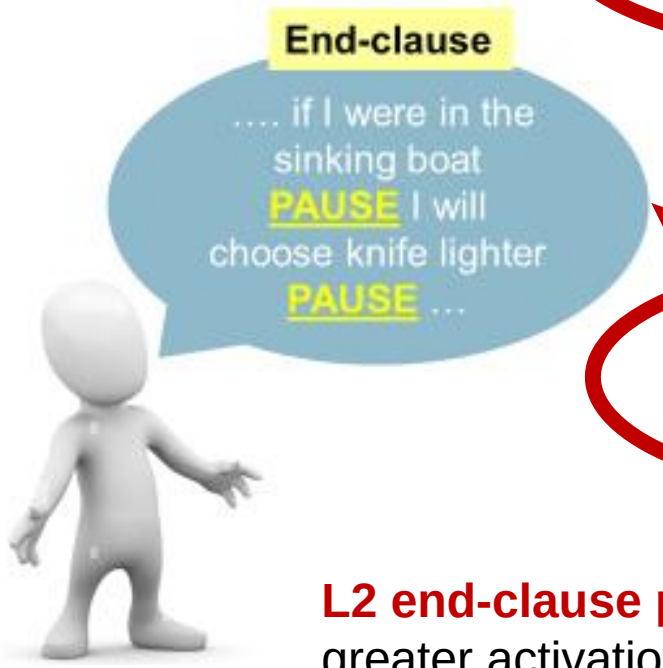


L2 (end-clause/mid-clause) pausing during **more complex task**: greater activation in **language-related** areas

Hypotheses: Language effects

Same in first and second language





behavioural

No language effects on end-clause pausing

neural

No language effects on neural activity

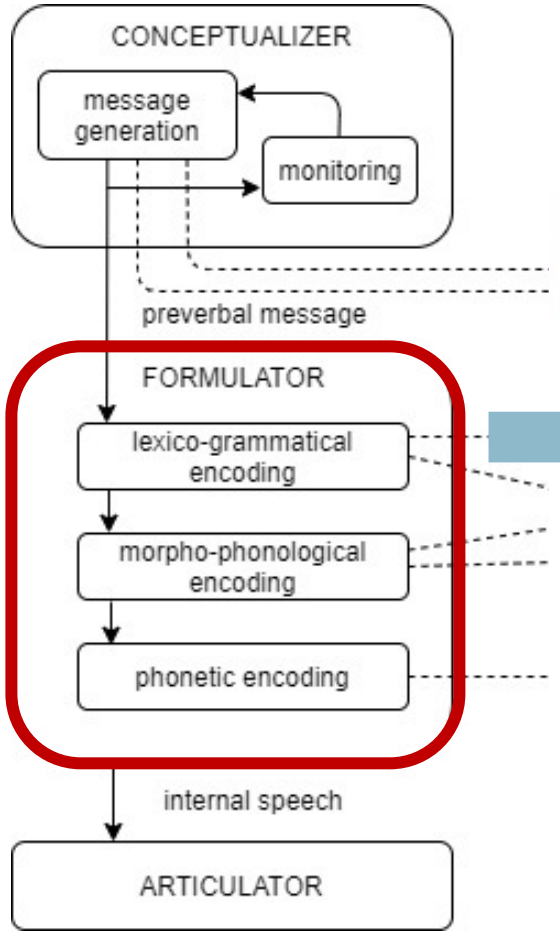
L2 end-clause pausing: greater activation in one **conceptualisation-related area**

Discussion

Why, additional activation in the L2?

- Probably retrieving semantic concepts in the L2 was more demanding than in L1 due to limited proficiency and experience in L2

Hypotheses: Language effects



More challenging in second than first language

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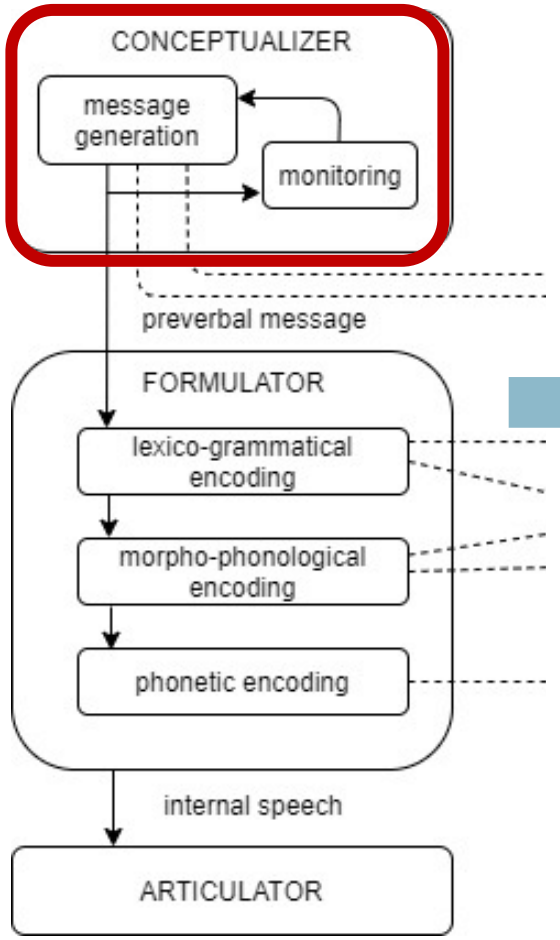
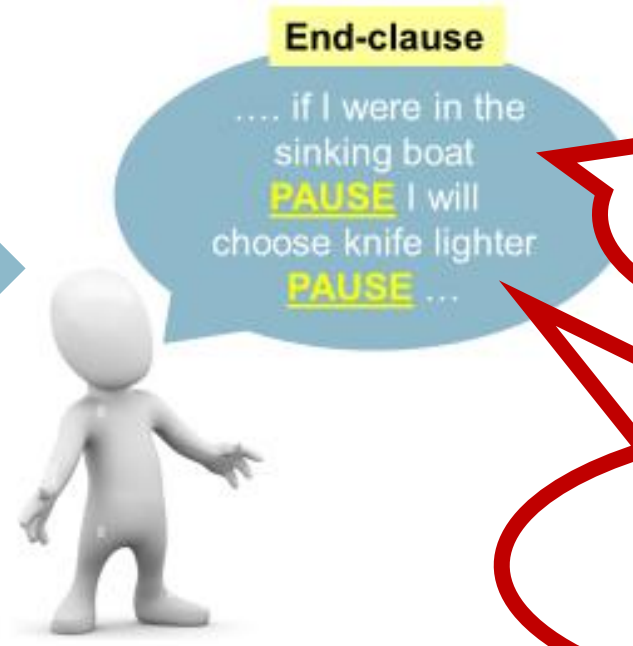
Greater pressure during more demanding tasks





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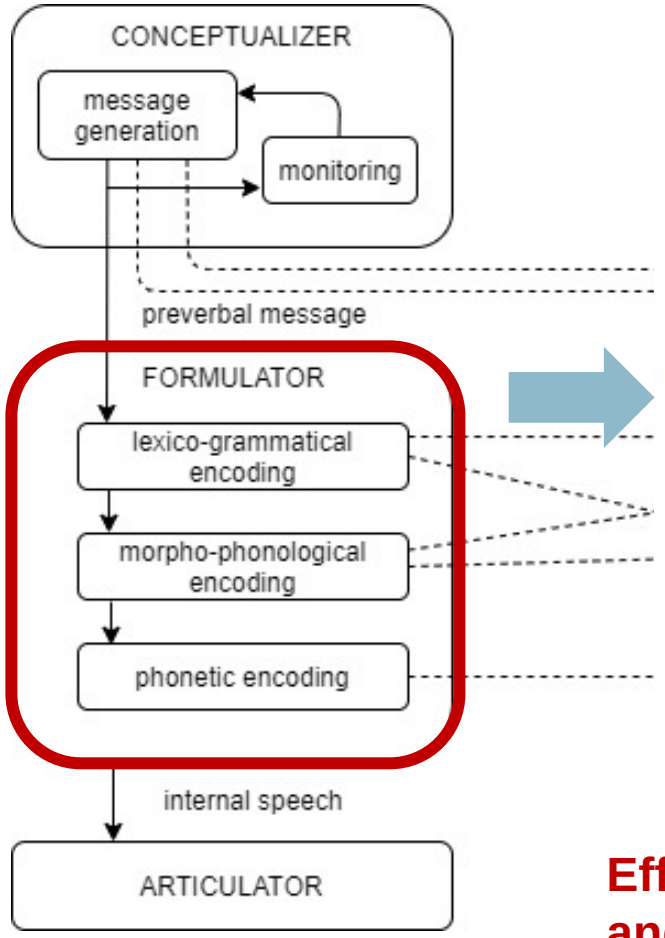
Hypotheses: Cognitive task demands

Greater pressure during more demanding tasks in second language



behavioural

More demanding tasks: more and longer mid-clau in second langu

neural

More demanding tasks: greater neural activity in language brain areas in second language

Effect found for both mid- and end-clause pausing

De Jong (2016); Rizantseva (2001)

Implications: Methodology

- One of the first studies to combine **behavioural** and **brain-imaging** methods to study **spontaneous speech production**
- Neural data appeared more sensitive to detect processing differences (language and task effects) than behavioural speech production data

Implications: Preparing second language users to operate in crisis settings

- The neuroscience data: differences not only in language but also conceptualisation areas during second language and during more complex crisis-related tasks

- To decrease cognitive load on conceptualisation and thus increase preparedness, second language learners need to practice using second language in crisis situations they might face (e.g., natural disaster).

- Likely to induce better second language performance in terms of deciding what to say and how to say it in real-life crisis situations.


THANK YOU