The sustained anterior negativity and syntactic movement dependencies in Korean

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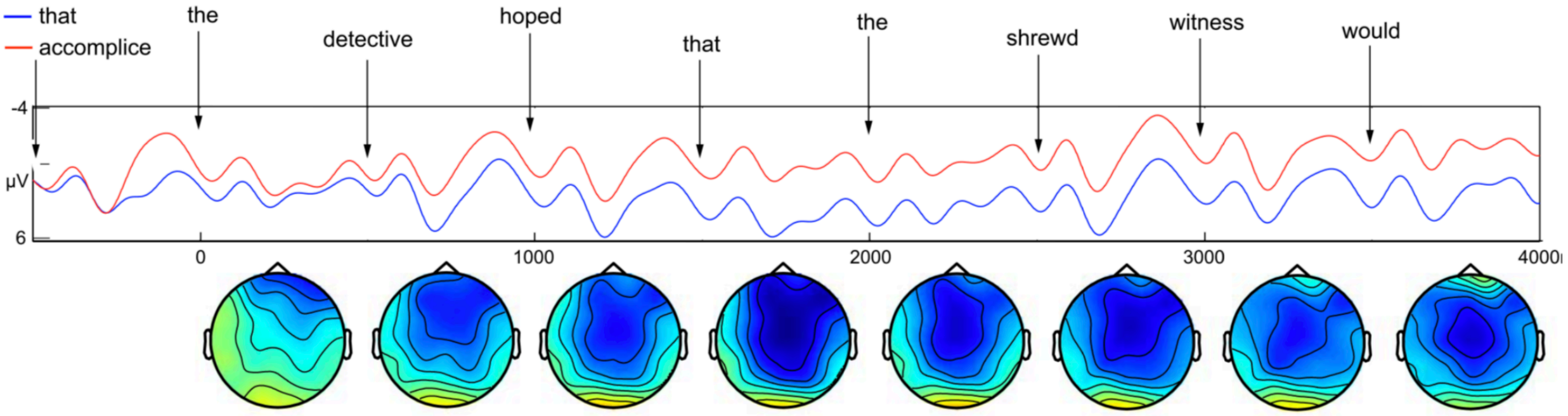
The Sustained Anterior Negativity

Sustained Anterior Negativity (SAN): First found by King and Kutas (1995); a negative going deflection that begins a couple of words after the onset of a dependency; the deflection is sustained for the length of the dependency, and has an anterior scalp distribution.

Philips et al. (2005) compared wh-dependencies to declarative sentences, showing a canonical looking SAN.



Other studies showing a SAN, a.o.:

King & Kutas (1995): Subject relative sentence vs. Object relative sentence

Fiebach et al. (2002): Subject wh-question vs.Object wh-question

Ueno & Kluender (2003): In-situ question vs. Scrambled-question

What is driving the SAN? (=what's the source?)

The descriptive fact is that the SAN arises during the processing of A'-dependencies, between the filler and gap. So the question is what processing mechanisms are deployed during these sentences that the SAN could be indexing?

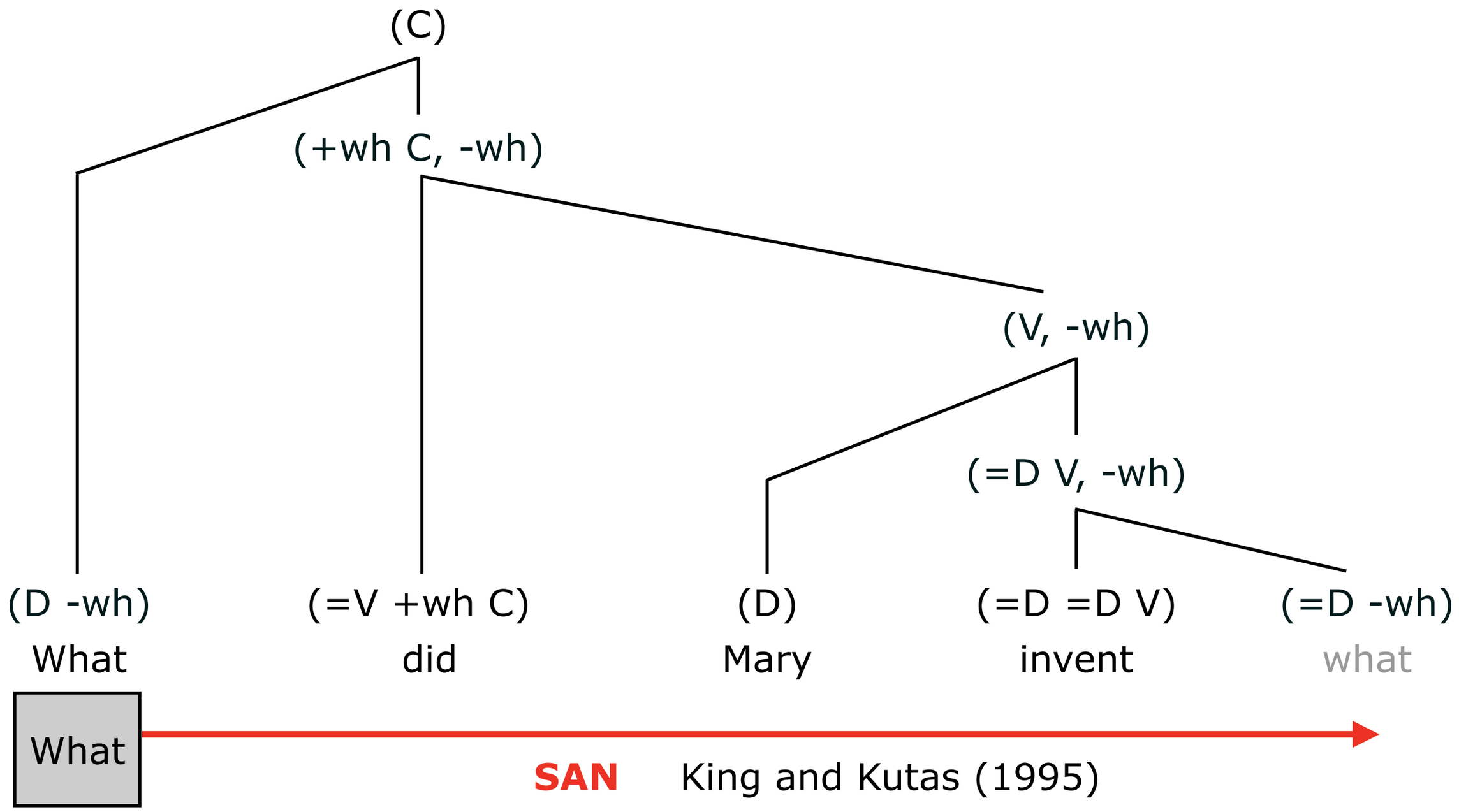
Theory 1: **Maintenance theory**
SAN is triggered by the effort required to hold **the full lexical item** in memory (King & Kutas 1995) so that it can be integrated later (perhaps for semantic reasons).

Theory 2-broad: **Unsaturated feature theory**
SAN is triggered by **any (unfulfilled) linguistic feature** that must travel along the parse (modifying the nodes in the parse) to fulfill a dependency.

Theory 2-narrow: **Movement feature (or internal merge)**
SAN is triggered specifically by **movement feature** that must travel along the parse (modifying the nodes of the parse) to fulfill a movement dependency (classic slash passing).

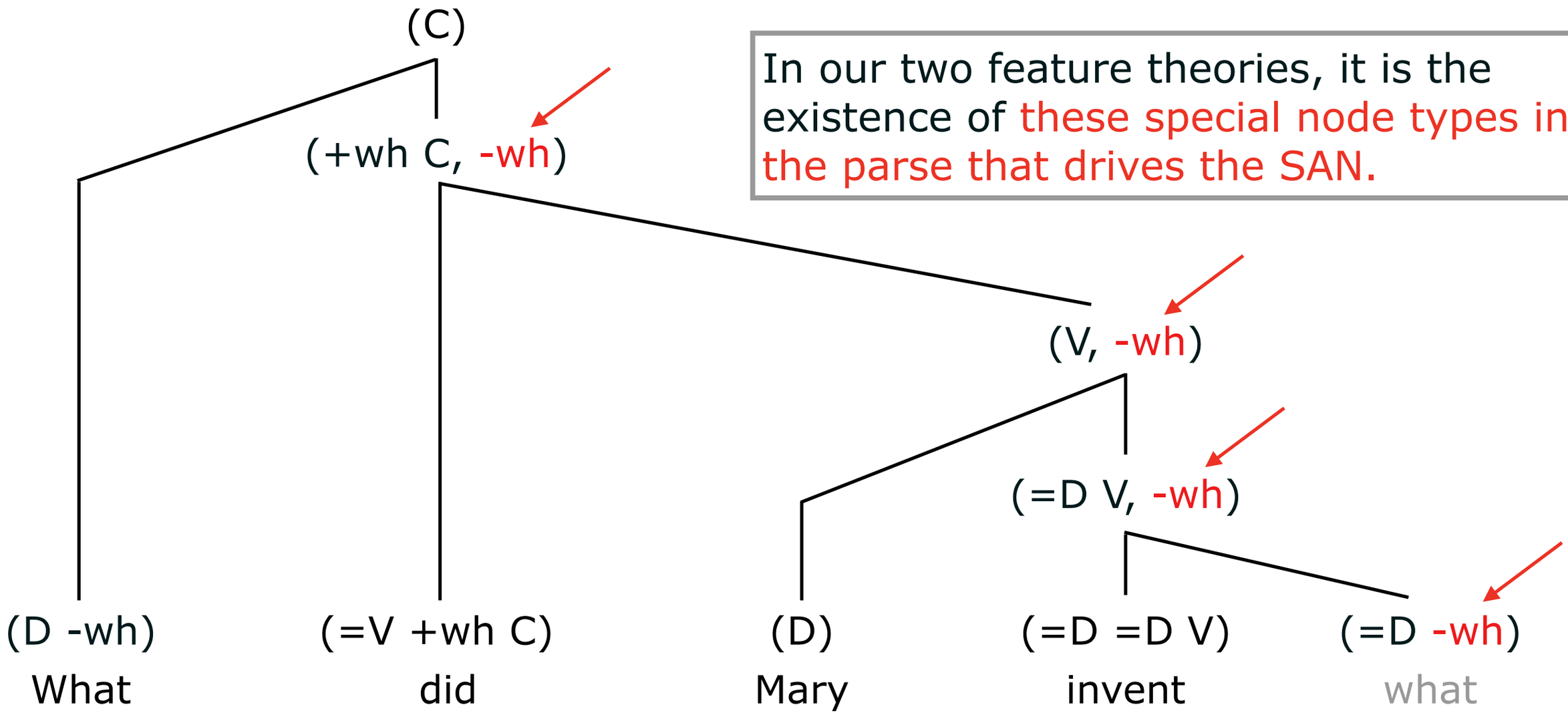
The Maintenance Theory

In memory theories where maintenance is costly (e.g., Just and Carpenter 1992), the storage of the filler for later semantic integration would drive the SAN.



The syntactic feature theories

When parsing a dependency in a left-corner parser (e.g., Hunter 2018), nodes dominating the tail of the dependency (e.g., gap) will have the unchecked feature as part of their specification (using a comma or slash). Illustrated here using a Stabler-style minimalist tree (Stabler 1997, Collins and Stabler 2016).



In our two feature theories, it is the existence of these special node types in the parse that drives the SAN.

What

In newer memory theories, maintenance has no cost (e.g., McElree 2003).

Our goals for today

Previous studies mainly focus on obligatory wh-movement languages such as English or German.

In the current project, we look at number of different syntactic dependencies in Korean, a wh-in-situ language:

1. To narrow down the theories of the SAN.

NP-scrambling	NP … ___ …
Wh-scrambling	who/what … ___ …
NCI licensing	NCI … V-NEG …

2. To try to look for a SAN for a covert movement dependency. We will use *totaychey* for this.

totaychey (wh-the-hell)	*totaychey* (…) who/what … Q

Goal 1: Narrow down the theories

1) NP-scrambling

kangdo-lul$_i$ ku yongkamhan kyengchal-i unhayng-eyse tanpeney t_i cheyphohayss-supni-kka?
robber-ACC the brave police-NOM bank-at immediately arrested-HON-Q
'Did the brave police immediately catch the robber at the bank?'

2) Wh-scrambling

nwuku-lul$_i$ ku yongkamhan kyengchal-i unhayng-eyse tanpeney t_i cheyphohayss-supni-kka?
who-ACC the brave police-NOM bank-at immediately arrested-HON-Q
'Who did the brave police immediately catch at the bank?'

3) NCI-licensing (Negative Concord Item = *amwuto*)

amwuto ku phyenghwalowun kongwen-eyse maykcwu-lul masici-anh-ass-ta.
nobody the peaceful park-at beer-ACC drink-NEG-PST-DECL
'No one drank beer at the peaceful park.'

<Predictions about the SAN>

	Maintenance	Unsaturated feature	Movement feature
NP-scrambling	SAN	SAN	SAN
Wh-scrambling	SAN	SAN	SAN
NCI-licensing	—	SAN	—

Goal 2: Find a SAN for covert movement

Under minimalism, overt and covert movement are the same operation.
They are driven by the same feature (e.g., -wh), and yield the same structure.
The difference is just in which end of the dependency is spelled-out.

Therefore in a parse, there will be the same set of special comma/slash nodes dominating the gap, which could drive a SAN.

In this way, covert movement provides an interesting test case for the SAN.
If the SAN is maintenance, there should be no SAN for covert movement.
But if the SAN is driven by syntactic features, there should be a SAN.

<Predictions about the SAN>

	Maintenance	Unsaturated feature	Movement feature
NP-scrambling	SAN	SAN	SAN
Wh-scrambling	SAN	SAN	SAN
NCI-licensing	—	SAN	—
covert movement	—	SAN	SAN

Goal 2: Find a SAN for covert movement

The problem with using covert movement in a processing study is that it is difficult to unambiguously mark a sentence as containing an in-situ wh-word. The parser needs to know there is a dependency in order for it to postulate the special comma/slash nodes.

We would like to use *totaychey* (the hell) to unambiguously mark the dependency (in matrix clauses), because *totaychey* requires an in-situ wh-word, thus signaling that there is a covert movement dependency from the first word in the sentence.

The problem: it is currently unclear whether *totaychey* is base generated (=(1)) in Spec,CP, or overtly moves to Spec,CP (=2)) (Huang and Ochi 2004).

(1) [$_{CP}$ *totaychey* [$_{IP}$ NP … [$_{VP}$ Adv who/what … V]] Q]

(2) [$_{CP}$ *totaychey* [$_{IP}$ NP … [$_{VP}$ Adv ___ who/what … V]] Q]

So we will keep both in mind

1. Base generation of totaychey in Spec,CP + covert movement of wh-phrase
2. Overt movement of totaychey to Spec,CP + covert movement of wh-phrase

Theory	**Predictions about the SAN**	
	(1) base + covert	(2) overt + covert
Maintenance	—	**???**
Unsaturated	SAN (covert)	SAN (either)
Movement	SAN (covert)	SAN (either)

Unclear issue: Does the full representation of *totaychey* need to be kept in working memory the way that moved wh-words do (for semantic reasons)?

We won't be able to say for sure if the SAN is driven by covert movement in this study. But once we have the SAN facts, we can redouble our efforts to determine whether *totaychey* moves or not (we can mention two options for this at the end).

Combining the predictions

Three theories of SAN make different predictions for each dependency type.

For the *totaychey* construction, the predictions depend on the analysis.

	Maintenance	Unsaturated feature	Movement feature
NP-scrambling	SAN	SAN	SAN
Wh-scrambling	SAN	SAN	SAN
NCI-licensing	—	SAN	—
(1) base + covert	—	SAN (covert)	SAN (covert)
(2) overt + covert	???	SAN (either)	SAN (either)

Two additional requirements for SANs

1. SANs only arise for object wh-questions (Fiebach et al. 2002)

   ➡ All of our scrambling conditions are objects.

2. SANs only arise for scrambled NPs that are new information (Yano and Koizumi 2018)

   ➡ All of our scrambled NPs are new.

(These raise interesting questions about the SAN that we can discuss in the question period if there is interest.)

The conditions

NP-scrambling

kangdo-lul$_i$ ku yongkamhan kyengchal-i unhayng-eyse tanpeney t$_i$ cheyphohayss-supni-kka?
robber-ACC the brave police-NOM bank-at immediately arrested-HON-Q

NP-in-situ (control)

ku yongkamhan kyengchal-i unhayng-eyse tanpeney kangdo-lul cheyphohayss-supni-kka?
the brave police-NOM bank-at immediately robber-ACC arrested-HON-Q
'Did the brave police immediately catch the robber at the bank?'

Wh-scrambling

nwuku-lul$_i$ ku yongkamhan kyengchal-i unhayng-eyse tanpeney t$_i$ cheyphohayss-supni-kka?
who-ACC the brave police-NOM bank-at immediately arrested-HON-Q

Wh-in-situ (control)

ku yongkamhan kyengchal-i unhayng-eyse tanpeney nwuku-lul cheyphohayss-supni-kka?
the brave police-NOM bank-at immediately who-ACC arrested-HON-Q
'Who did the brave police immediately catch at the bank?'

The conditions

NCI

amwuto ku phyenghwalowun kongwen-eyse maykcwu-lul masici-anh-ass-ta.
nobody the peaceful park-at beer-ACC drink-NEG-PST-DECL
'No one drank beer at the peaceful park.'

NCI control

cwumintuli ku phyenghwalowun kongwen-eyse maykcwu-lul masici-anh-ass-ta.
neighbors-NOM the peaceful park-at beer-ACC drink-NEG-PST-DECL
'Neighbors didn't drink beer at the peaceful park.'

***totaychey* (wh-the-hell)**

totaychey ku yongkamhan kyengchal-i unhayng-eyse tanpeney nwuku-lul$_i$ cheyphohayss-supni-kka?
the-hell the brave police-NOM bank-at immediately who-ACC arrested-HON-Q

Wh-in-situ (control)

ku yongkamhan kyengchal-i unhayng-eyse tanpeney nwuku-lul cheyphohayss-supni-kka?
the brave police-NOM bank-at immediately who-ACC arrested-HON-Q
'Who did the brave police immediately catch at the bank?'

A sanity check: A classic N400 paradigm

Semantic congruent

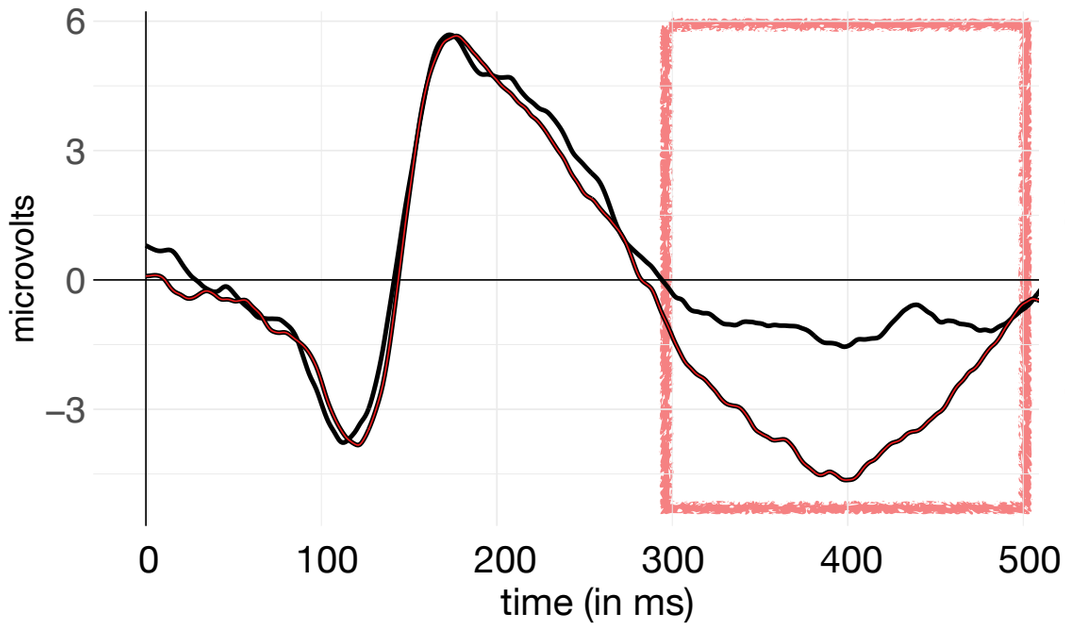
Cayhwun-ika kaphalun san-ul yelsimhi ollassta.
Cayhwun-NOM stiff mountain-ACC diligently climb-PST-DECL
'Cayhwun diligently climbed the stiff mountain.'

Semantic incongruent

Daeun-ika kocangnan **khemphyuthe-lul** sinsokhakey **kkulhye-ss-ta**.
Daeun-NOM broken **computer-ACC** quickly **boil-PST-DECL**
'Daeun quickly boiled the broken computer.'

First, this shows that the participants are reading the sentences for content (in addition to the comprehension questions mentioned on the next slide).

Second, this lets us look for a well-established ERP to make sure our equipment is functioning properly.

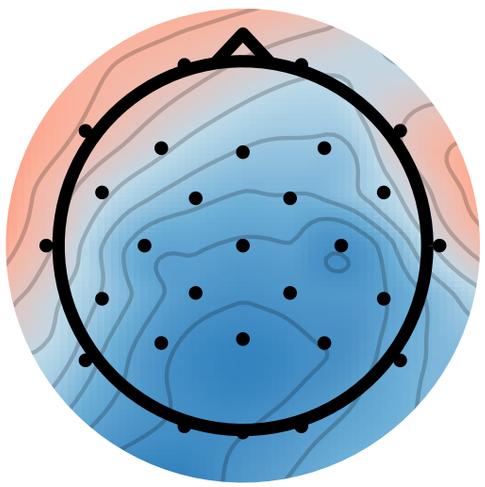


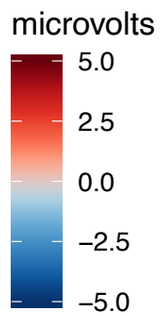
Cz

Semantic congruent:

Semantic incongruent:

300-500ms





The details of our experiment

The items:
Each subject saw **270 items plus 10 practice items** in their session.
9 conditions, with 30 items per sentence type (=270 items).
4 types of dependencies, 3 control conditions (NP-in-situ, Wh-in-situ, and NIC control), and 2 conditions forming a classic N400 paradigm as an extra control.

Sentences were presented word-by-word using the **Rapid Serial Visual Presentation** (RSVP) paradigm.

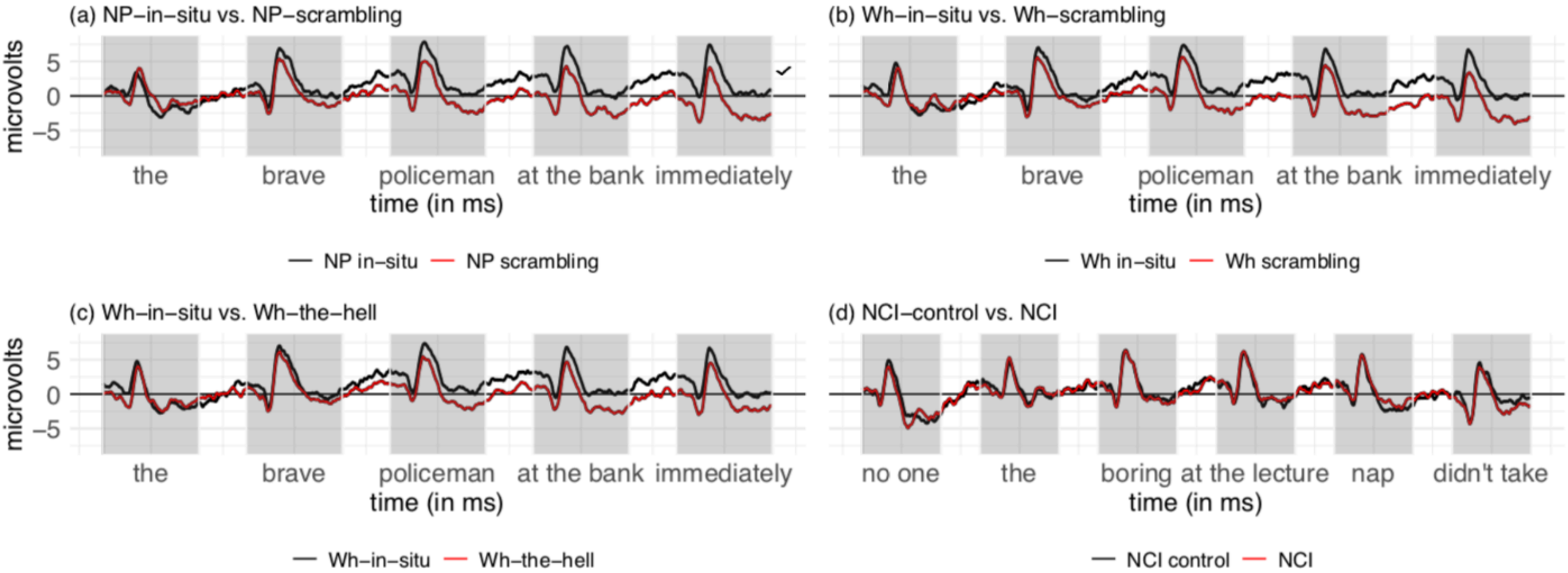
The presentation rate: 500ms on, 250ms off (750ms SOA, 250ms ISI)

The number of channels in the EEG: 32 channels

Participants: 21 self-reported native speakers of Korean from the University of Connecticut.

The task: Yes/No comprehension questions after 25% of items.

Grand average waveforms at electrode F3



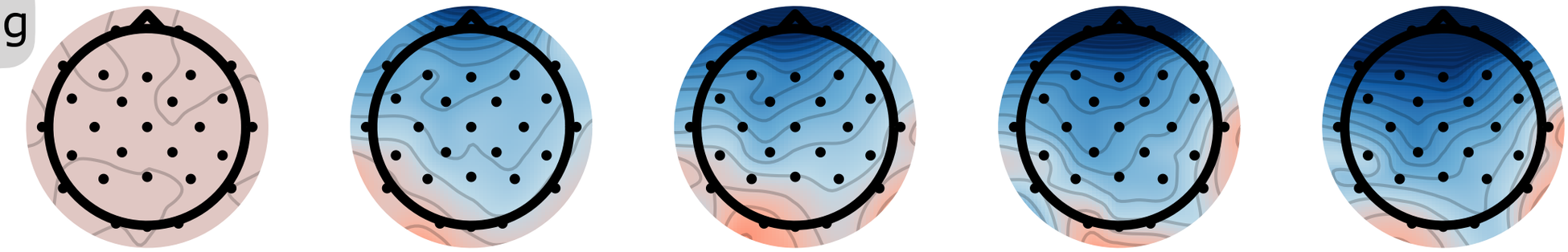
Baselined to 300-500ms after the first word in the plot, bandpass filtered at 0.1 and 30hz, with gray boxes indicating when each word was visible.

There is a clear SAN for NP-scrambling, Wh-scrambling, and *totaychey*, but not NCI.

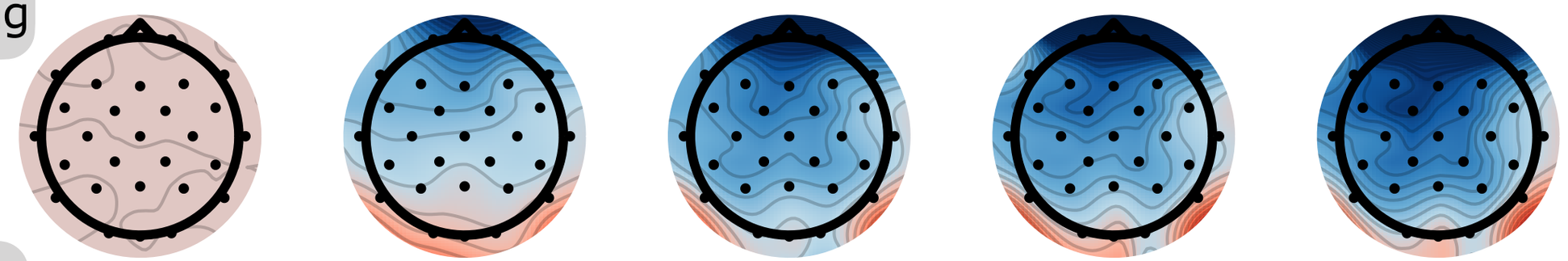
Scalp distributions of the SANs

the **brave** **policeman** **at the bank** **immediately**

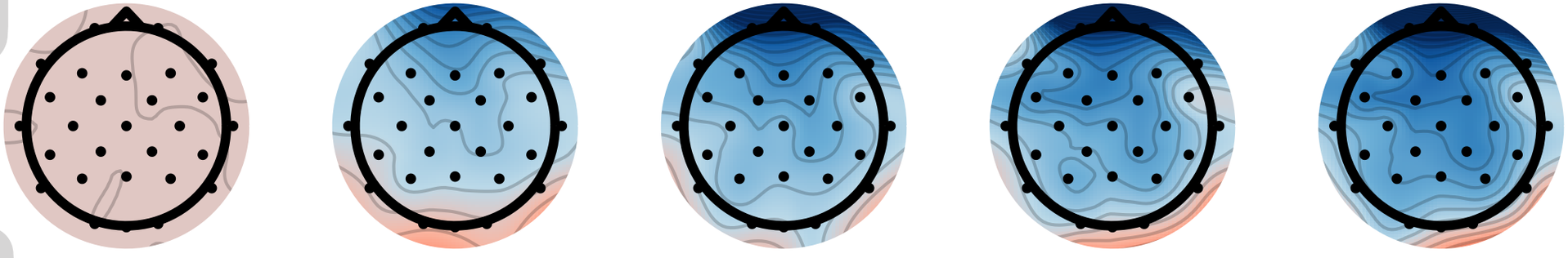
NP-scrambling



Wh-scrambling

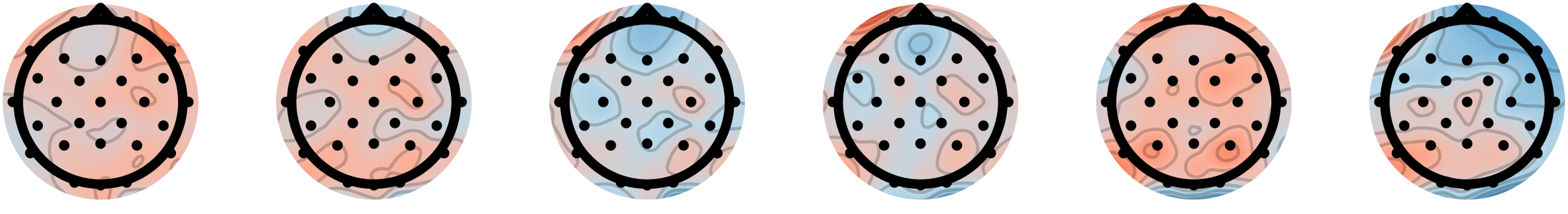


totaychey (wh-the-hell)



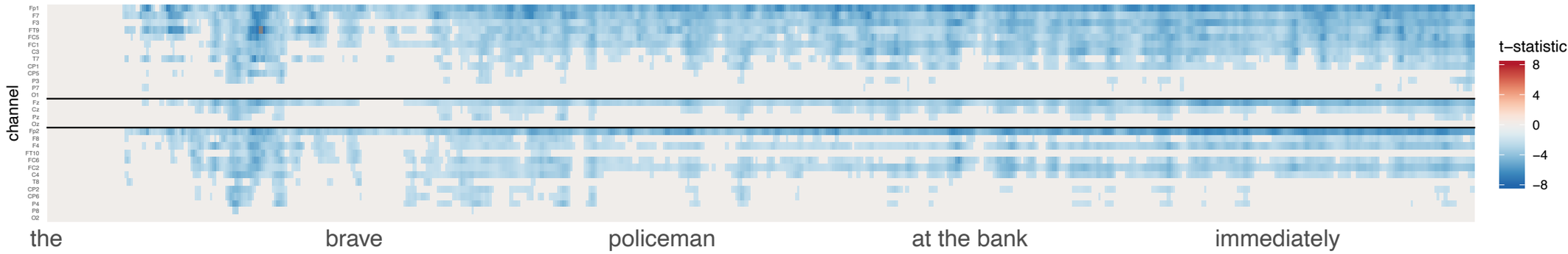
NCI-licensing

no one **the** **boring** **lecture** **nap** **didn’t take**



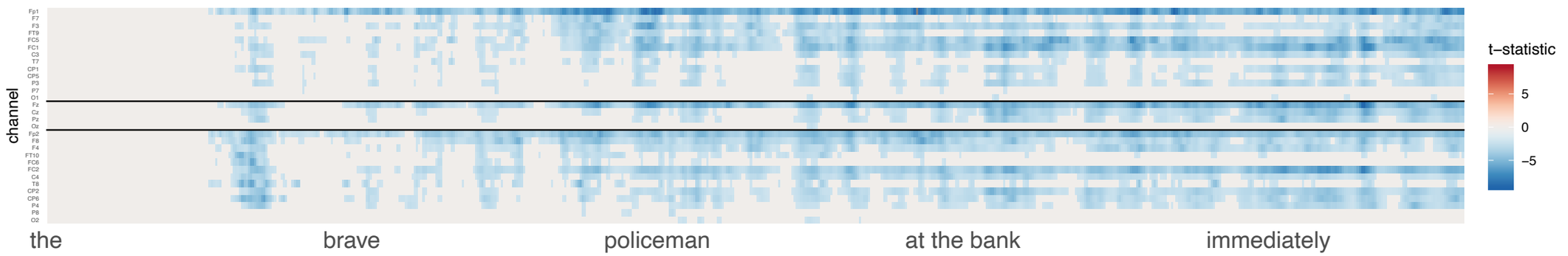
Mass univariate (cluster-based) permutation tests (Groppe et al. 2011)

NP-scrambling

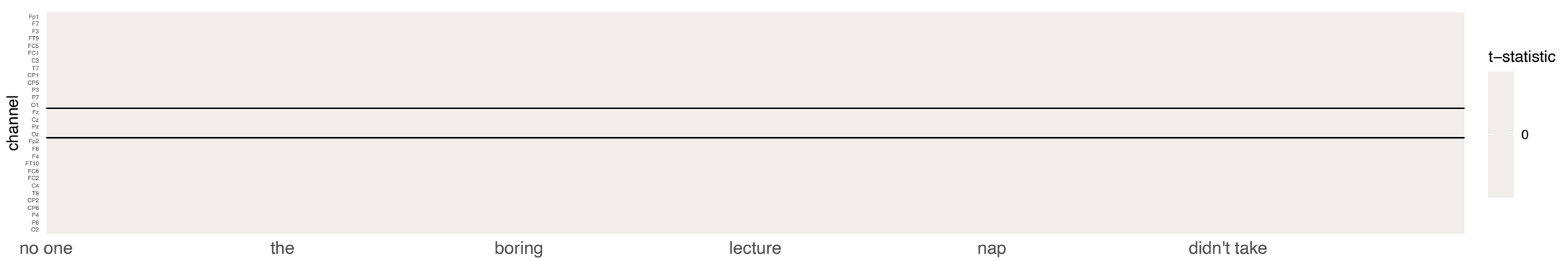


Wh-scrambling

totaychey (wh-the-hell)



NCI-licensing



Comparing the results to predictions

The pattern of results suggests that NP-scrambling, WH-scrambling, and *totaychey* form a group to the exclusion of NCI-licensing.

	Maintenance	Unsaturated	Movement	**Actual result**
NP-scrambling	SAN	SAN	SAN	**SAN**
Wh-scrambling	SAN	SAN	SAN	**SAN**
NCI-licensing	—	SAN	—	**—**
(1)base + covert	—	SAN (covert)	SAN (covert)	**SAN**
(2)overt + covert	???	SAN (either)	SAN (either)	

The NCI result suggests that **SANs are driven either by movement or by maintenance** (which make the same predictions in this experiment).

Comparing the results to predictions

	Maintenance	Unsaturated	Movement	**Actual result**
NP-scrambling	SAN	SAN	SAN	**SAN**
Wh-scrambling	SAN	SAN	SAN	**SAN**
NCI-licensing	—	SAN	—	**—**
(1)base + covert	—	SAN (covert)	SAN (covert)	**SAN**
(2)overt + covert	???	SAN (either)	SAN (either)	

The *totaychey* results either suggest that there is **movement** (of one or both items), or if SANs are maintenance, that totaychey must be stored in memory for later semantic interpretation (which seems unlikely but is perhaps possible).

Two follow-up EEG studies probing *totaychey*

1. If *totaychey* moves overtly, what could cause it?

Maybe a scrambling feature, or focus feature, etc. So we could first probe the **semantic consequences** of *totaychey* using traditional linguistic methods. And, we could look for the SAN to disappear in a context with givenness (Yano and Koizumi 2019). They argue that SANs only arise when the scrambled NP is a new information (given NPs don't yield SANs).

2. *totaychey* is possible with embedded polar questions.

totaychey na-nun [Mary-ka nayil phathi-ey onunci-anin-ci] al-swu-ep-ta.
the-hell I-TOP Mary-NOM tomorrow party-to come-not-Q know-NEG-DEC
'I don't know whether the hell Mary will come to party tomorrow or not'

These, obviously, have no wh-word, and therefore no covert movement of the wh-word. If we can unambiguously mark them as polar questions, we could look for a SAN. If we see one, it is driven by *totaychey*, and if we don't, we have some evidence that covert movement of wh-words is driving the SAN.

Conclusion and future directions

	Maintenance	**Movement feature**
(1) base + covert	—	SAN (covert)
(2) overt + covert	???	SAN (either)

Our results are tantalizing, as they suggest that it may be possible to one day conclude that **movement features drive the SAN,** and that the minimalist assumption that covert movement is identical to overt movement **could be supported by processing evidence**.

However, we need to further investigate the nature of *totaychey* to make that argument. For now, we are left with the new data points that NCI-licensing does not trigger a SAN, and *totaychey* with wh-in-situ does!

Thank you for listening!

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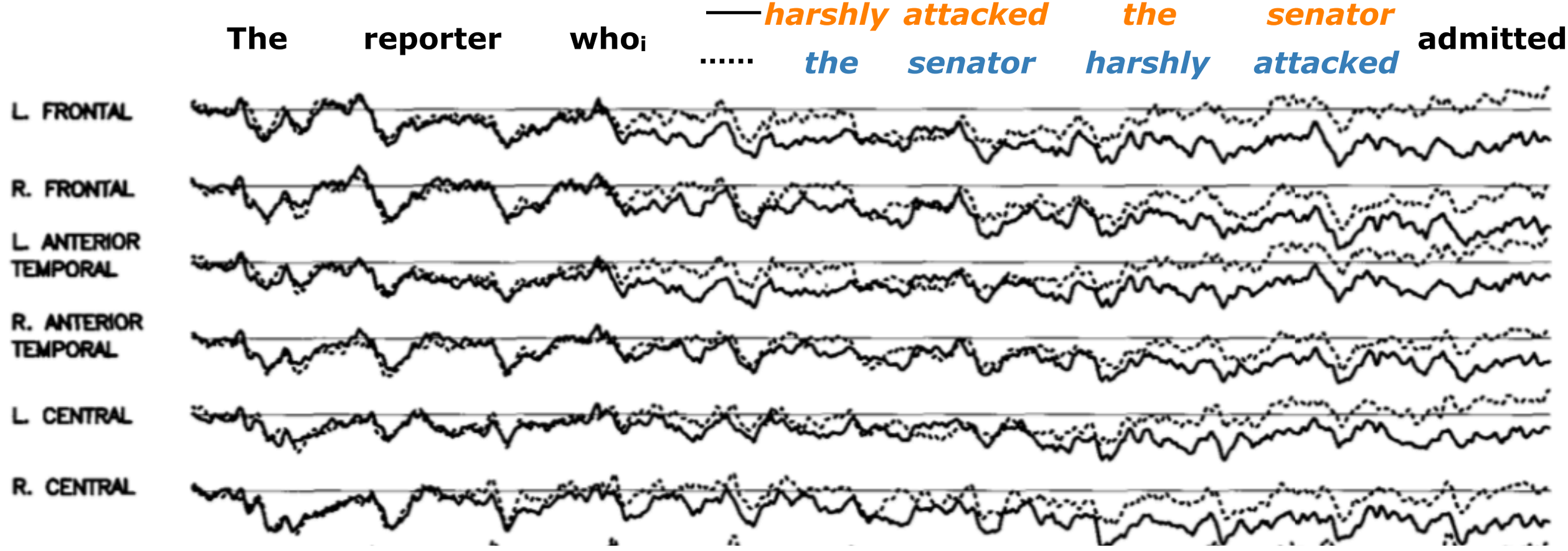
References upon request

King and Kutas 1995

Subject relative sentence:
The reporter [**who$_i$ t$_i$** harshly attacked the senator] admitted the error.

Object relative sentence:
The reporter [**who$_i$** the senator harshly attacked **t$_i$**] admitted the error.

King & Kutas reported that only object relative sentence shows the effect of SAN, suggesting that the SAN is an index of the working memory load to actively maintain the filler in the working memory.



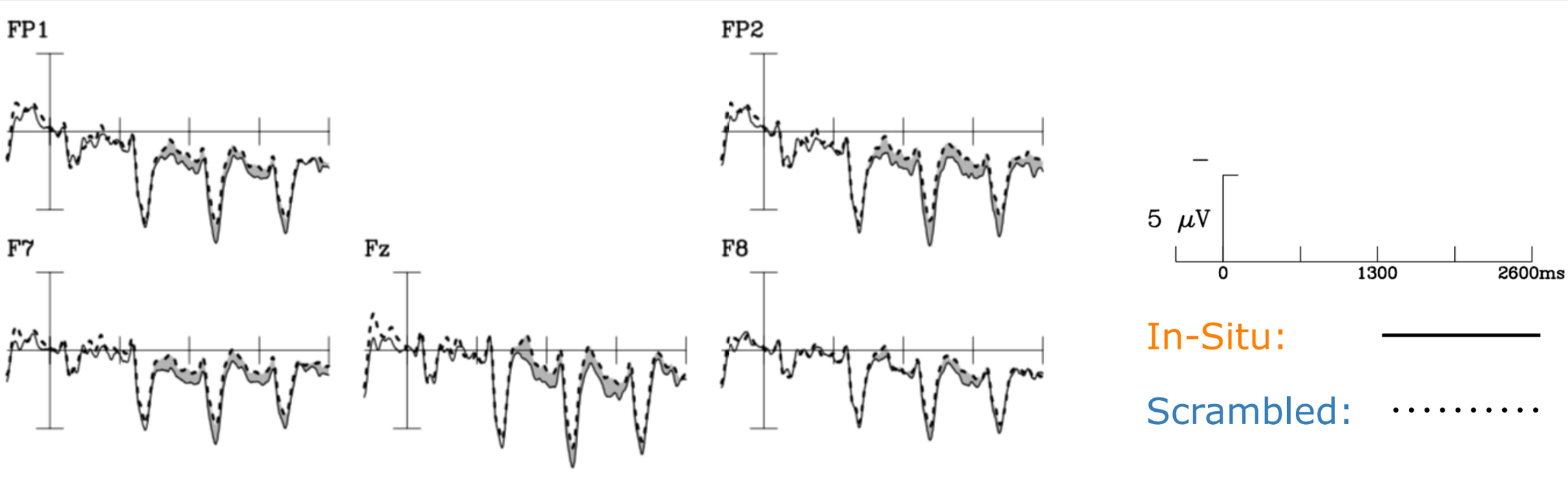
Ueno and Kluender 2003

In-Situ:…{sono inochishirazuno bokenka-ga toto} sore/nani-o mitsuketa-ndesu-ka.
…{that reckless adventurer-NOM finally} that/what-ACC discovered-POL-Q

Scrambled: … sore/nani-o {sono inochishirazuno bokenka-ga toto} mitsuketa-ndesu-ka.
… that/what-ACC {that reckless adventurer-NOM finally} discovered-POL-Q

'did that reckless adventurer finally discover that?/what did that reckless adventurer finally discover?'

Ueno & Kluender found that scrambled demonstrative and *wh*-objects elicited slow potential effect of increased bilateral anterior negativity in comparison to their in-situ counterparts. The study observed the SAN in scrambling contexts as well as in standard *wh* -movement contexts. The general results shows the similar patterns seen in English and German.



ERPs (n=20) for electrodes to sentence positions between filler and gap {that reckless adventurer-NOM. finally}, of scrambled vs. in-situ conditions, collapsed across demonstrative and wh conditions, and relative to a 100 ms poststimulus baseline.

Fiebach et al. 2002

Subject wh-question:

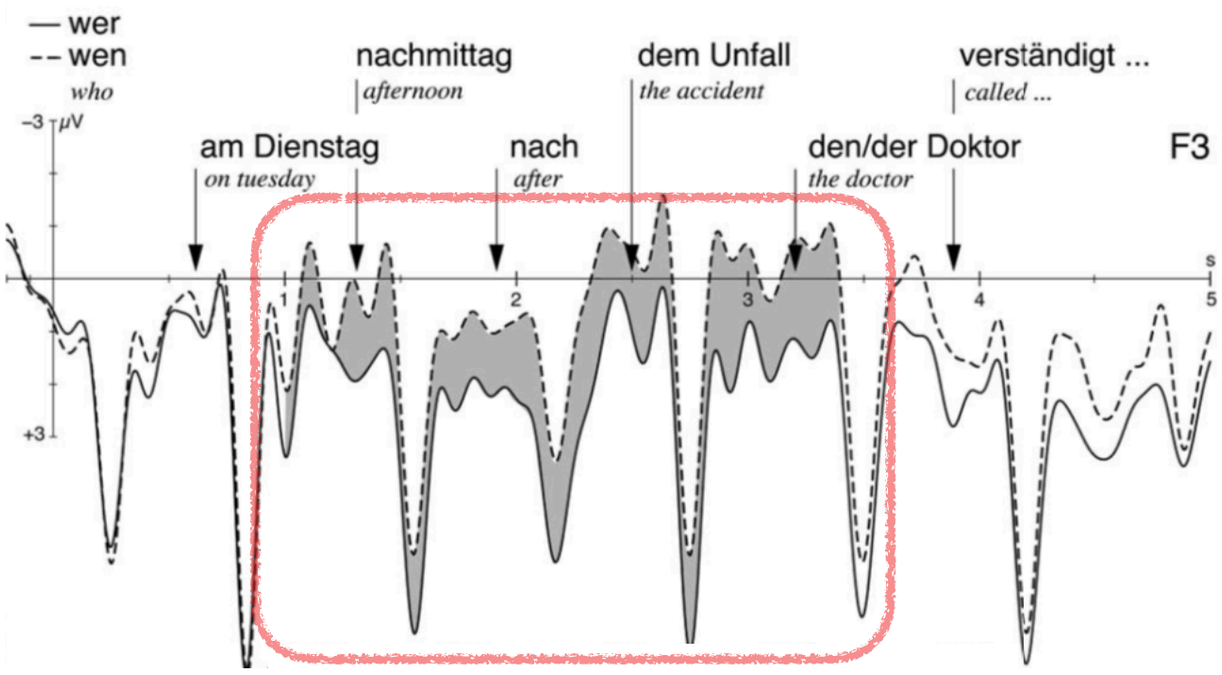
Thomas fragt sich, wer am Dienstag nachmittag nach dem Unfall __ den Doktor verständigt hat.
Thomas asks himself, who$_{(NOM)}$ on tuesday afternoon after the accident the$_{(ACC)}$ doctor called has.

Object wh-question:

Thomas fragt sich, wen am Dienstag nachmittag nach dem Unfall der Doktor __ verständigt hat.
Thomas asks himself, who$_{(ACC)}$ on tuesday afternoon after the accident the$_{(NOM)}$ doctor called has.

Fiebach et al. observed SAN for object wh-questions, but not for subject wh-questions, arguing that SAN reflects working memory processes required for **maintaining the dislocated object in memory**.

Multiword ERPs from F3.



Subject wh-question: ——

Object wh-question: .....

Point of this study: There is probably an **additional condition/requirement** to the theory of the SAN.

One possibility is that it is about (hyperactive) active gap filling: the gap location of the object wh-word may be less easily predicted than the gap location of the subject wh-word. SANs may be eliminated when the gap location can be immediately predicted. (Stowe 1986, Omaki et al. 2015)

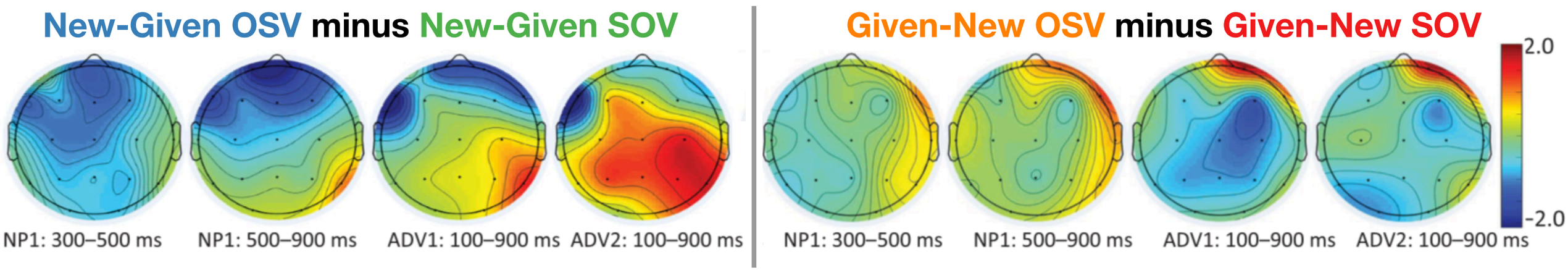
Yano & Koizumi 2018

SANs only arise when the scrambled NP is new information (given NPs don't yield SANs):

Context: Kooban-ni (a) Yoshida-san-ga / (b) Kimura-san-ga imasu.
police.box-in Yoshida-Mr-NOM / Kimura-Mr-NOM be
"(a) Mr. Yoshida / (b) Mr. Kimura is in the police box."

S_{NEW} O_{GIVEN} V	Mr.Yoshida-NOM	yesterday-GEN night	**Mr.Kimura-ACC** forgave seem
S_{GIVEN} O_{NEW} V	**Mr.Yoshida-NOM**	yesterday-GEN night	Mr.Kimura-ACC forgave seem
O_{NEW} S_{GIVEN} V	Mr.Kimura-ACC	yesterday-GEN night	**Mr.Yoshida-NOM** forgave seem
O_{GIVEN} S_{NEW} V	**Mr.Kimura-ACC**	yesterday-GEN night	Mr.Yoshida-NOM forgave seem

"It seems that Mr.Yoshida forgave Mr.Kimura last night."



Grand average ERPs from NP1 to NP2. (Boldface in the legend indicates discourse-given NPs).