

Phonemic Buffer Properties

A case study of an aphasic patient exhibiting position and length effects in lexical production.

Credits

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The importance of studying sound errors

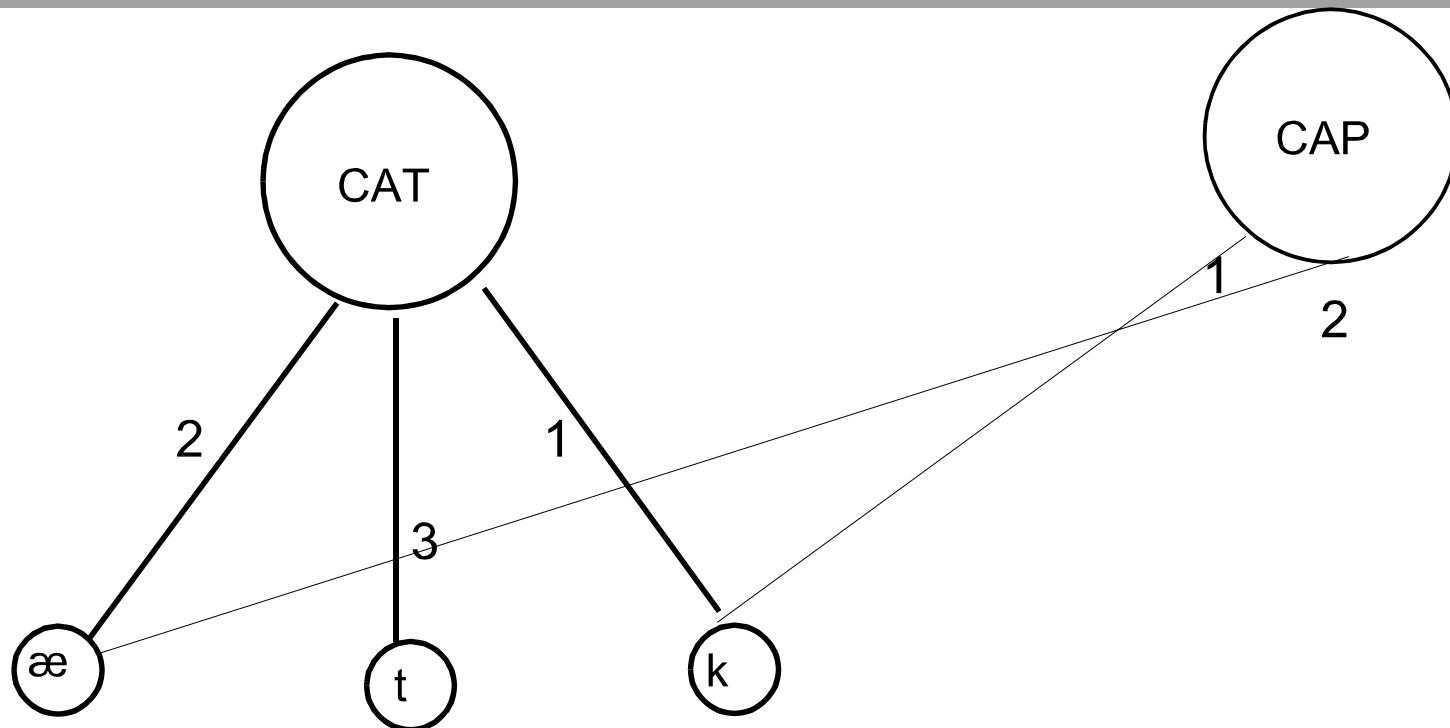
Sound errors are not random and constrained.
Hence, the study of these errors can tell us something about the architecture of the phonological processor.

Among normal subjects phonological errors usually:

- involve segments close to each other
- insensitive to grammatical class
- preserve syllabic structure of the target words.

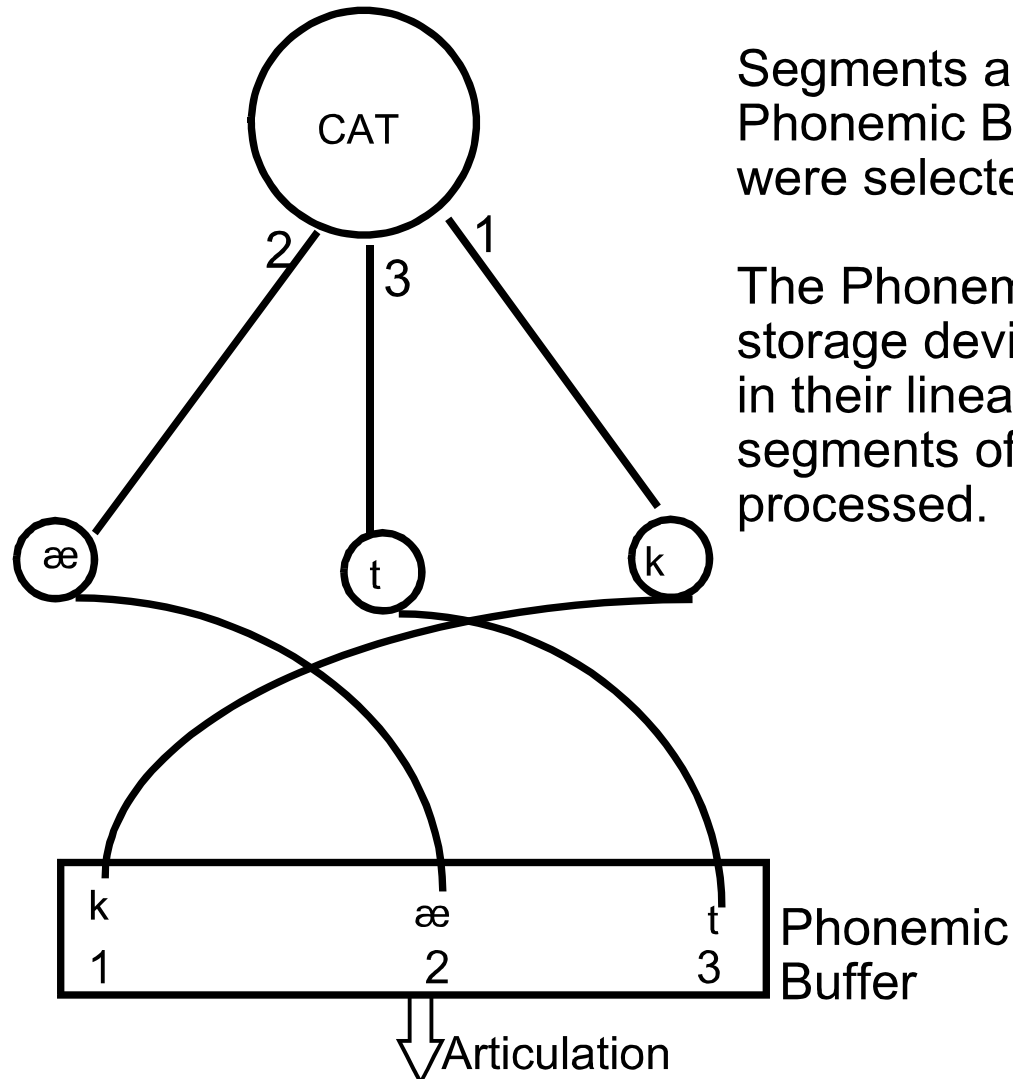
Left hemisphere -> heft Jemisphere

Lexical production



Individual segments are activated by the selected lexical item.
Phonemes are not inherently specified for linear order since they are not word specific.
Instead, a given lexical node activates phoneme nodes in the order they are going to be produced.

Properties of the Phonemic Buffer



Segments are inserted into a Phonemic Buffer in the order they were selected.

The Phonemic Buffer is a memory storage device. It stores phonemes in their linear order until all the segments of a given word are processed.

This case study

- This case study will try to address two issues:
 1. Performance of a patient exhibiting position and length effects in repetition
 2. The properties of the Phonemic Buffer

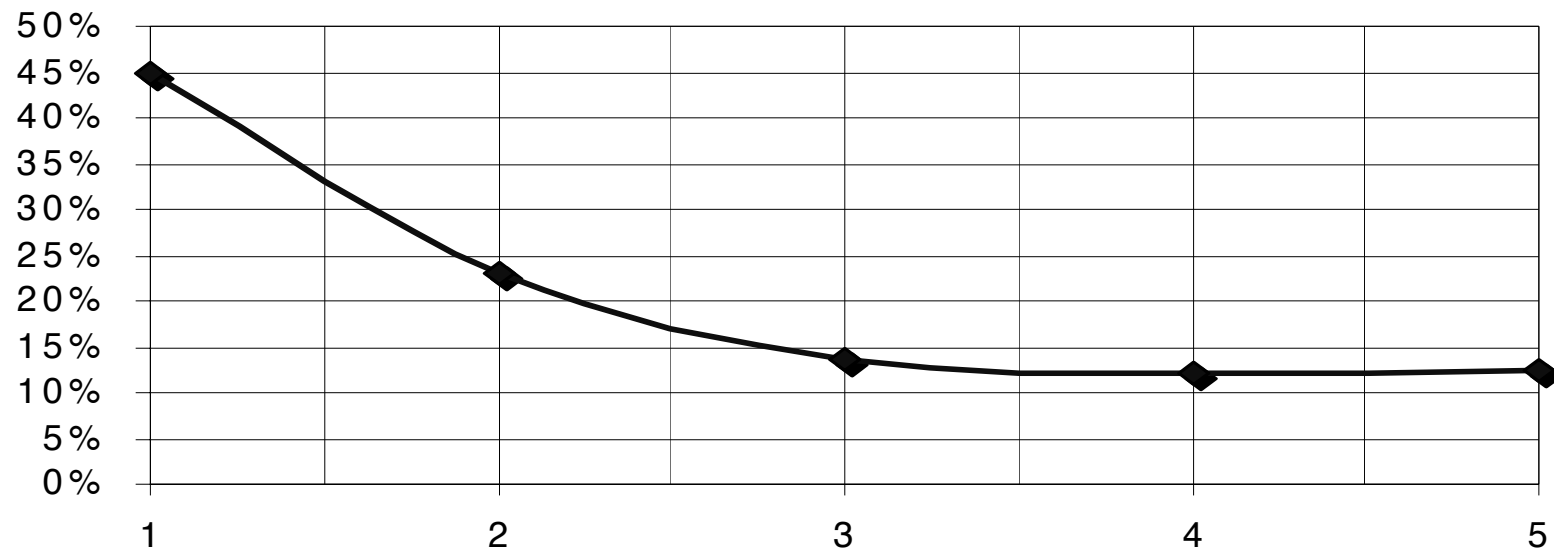
RC - Patient Description

- RC is a 62 year-old right-handed man (post-onset left-handed) who suffered a stroke in June of 1994. We began testing RC in May of 1997 and continued through April of 1999. His performance was consistent throughout the entire testing period.
- CT and MRI scans show that RC had a left middle cerebral artery distribution infarction with extensive encephalomalacia and ex vacuo dilation of the lateral ventricle. RC was left with general paralysis of his right side.
- RC has a high school education.

Why is RC interesting?

- RC has a substantial amount of phonological errors in word/non-word repetition and naming that are located at the beginning of the word.
- This is an unusual pattern since reported cases involve an increase in errors at the end of a word (Wilshire & MacCarthy 1999)

Average errors for word and non-word repetition by position



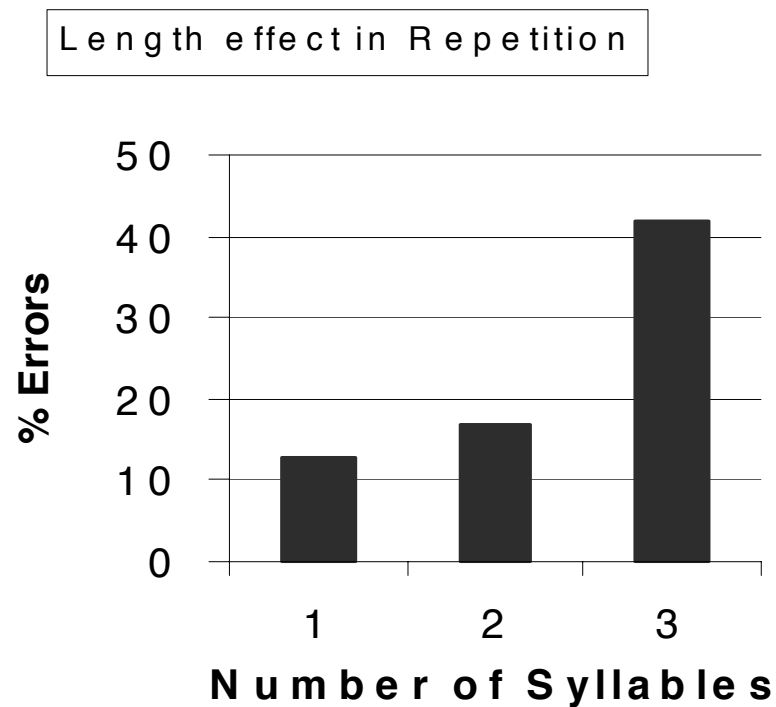
RC - examples of errors in repetition

abbreviate	breviate	preclude	pleeclude
academy	cademy	redrawn	dredrawn
accompany	company	replace	inplaced
acknowledge	knowledge	runway	oneway
annoyance	noyance	seal	eel
attention	tension	seesaw	x2 theesaw
attorney	turney	sheepskin	cheapskin

preclude	pleeclude	ambush	bush
redrawn	dredrawn	balloon	abloon
replace	inplaced	circle	skirkle
runway	oneway	citric	stitrick
seal	eel	decent	cent
seesaw	x2 theesaw	deprive	beprive
sheepskin	cheapskin	displace	drisdrupt
sightly	lightly	freedom	shreedom
Social	showshal	giraffe	diraff

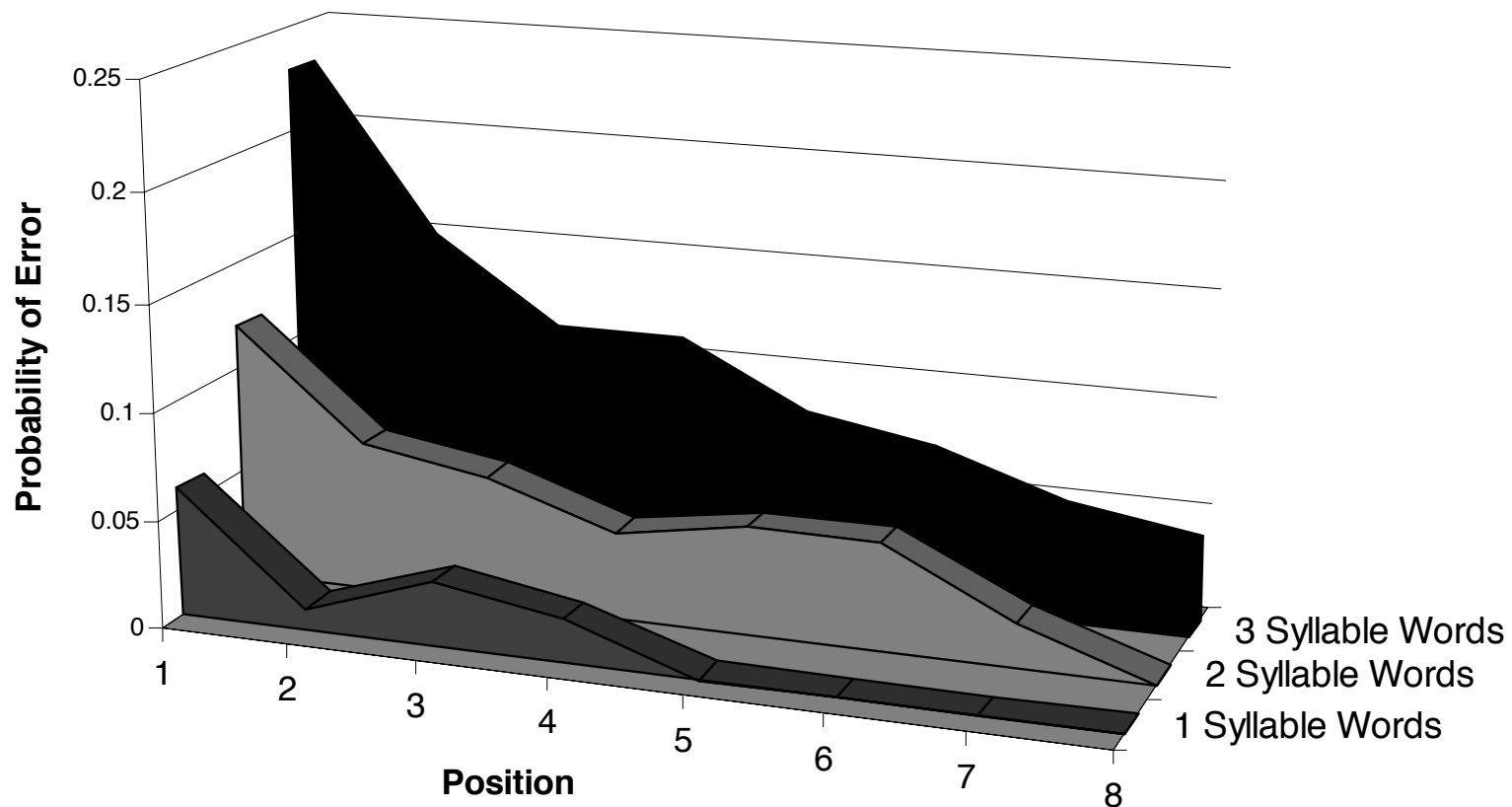
RC word repetition - the length effect

RC not only exhibits a tendency to make errors at the beginning of words, his errors also increase as with the length of the target word.



RC- word initial errors - error probability per position as a function of length

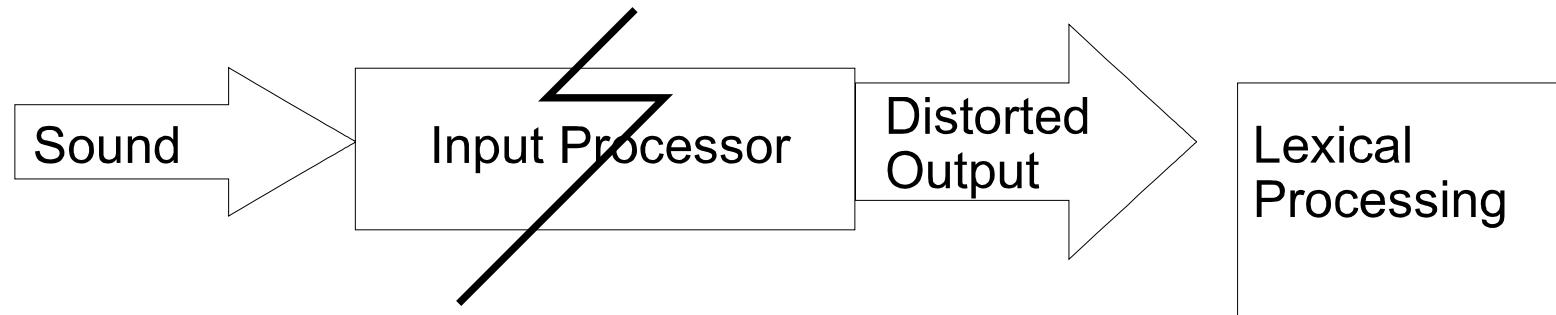
RC Repetition Errors:
Probability of Error per Position



Input Problems in repetition tasks

- Repetition tasks cannot discriminate between a lesion in the input system and the lexical processing system.

Repetition errors are not an input problem



In order to exclude a lesion in the input system RC was administered a picture matching minimal pair task. In it RC was asked to point to a picture depicting one of the words in a minimal pair like : CAP-TAP (presented aurally). He performed this task 100% correct.

RC- Examples of errors in Naming

erase	encil
eskimo	meskimo
giraffe	duhrafte
grapes	ruhgrapes
guitar	deecar
pajamas	jamass

Moreover, RC exhibits similar errors in Picture naming, a task that does not make use of the auditory input system.

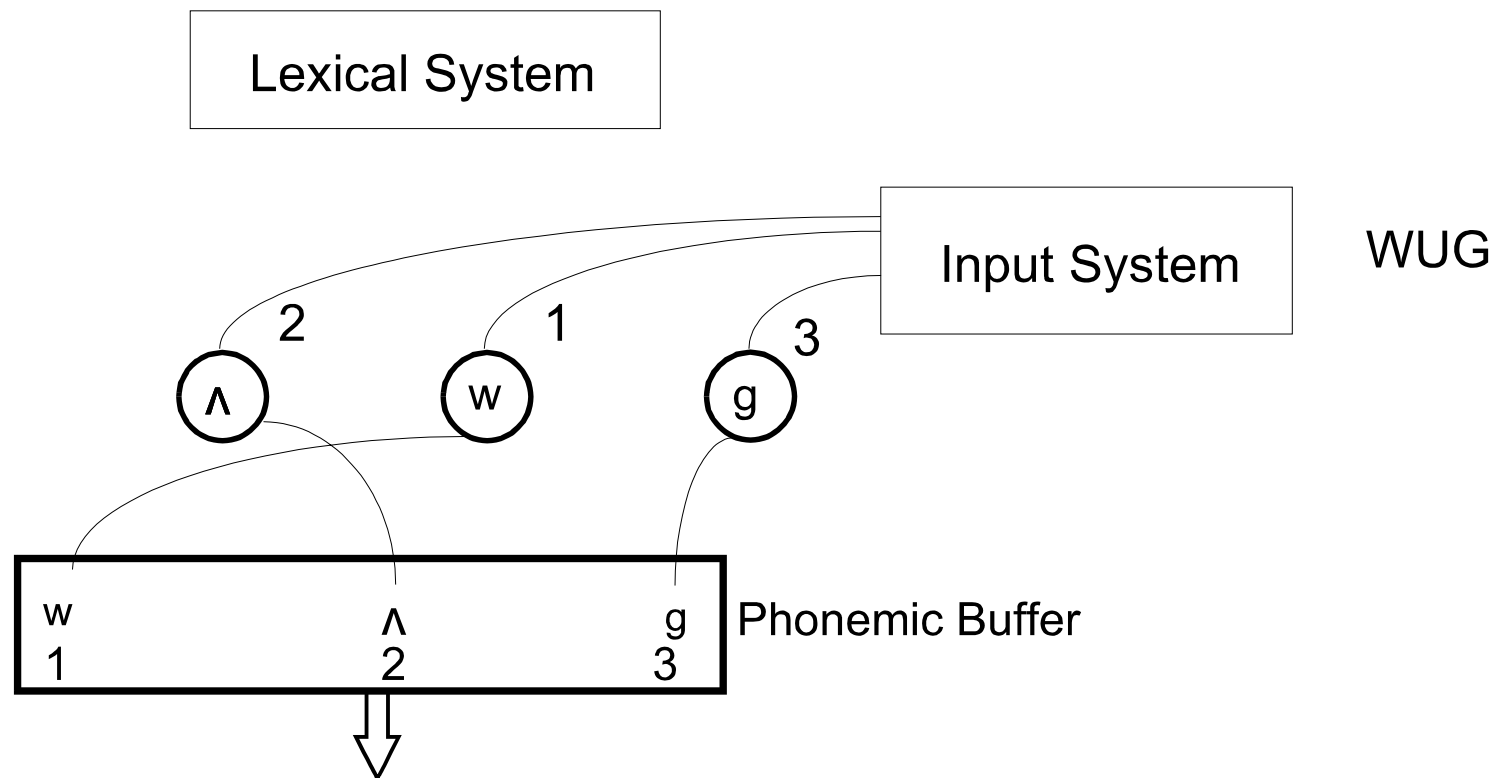
RC errors not an input effect

Evidence from Picture Naming and minimal pair recognition tasks indicates that RC's problem in Repetition is not a result of a lesion in his Input System.

Can we Establish if the lesion is in the Lexical System?

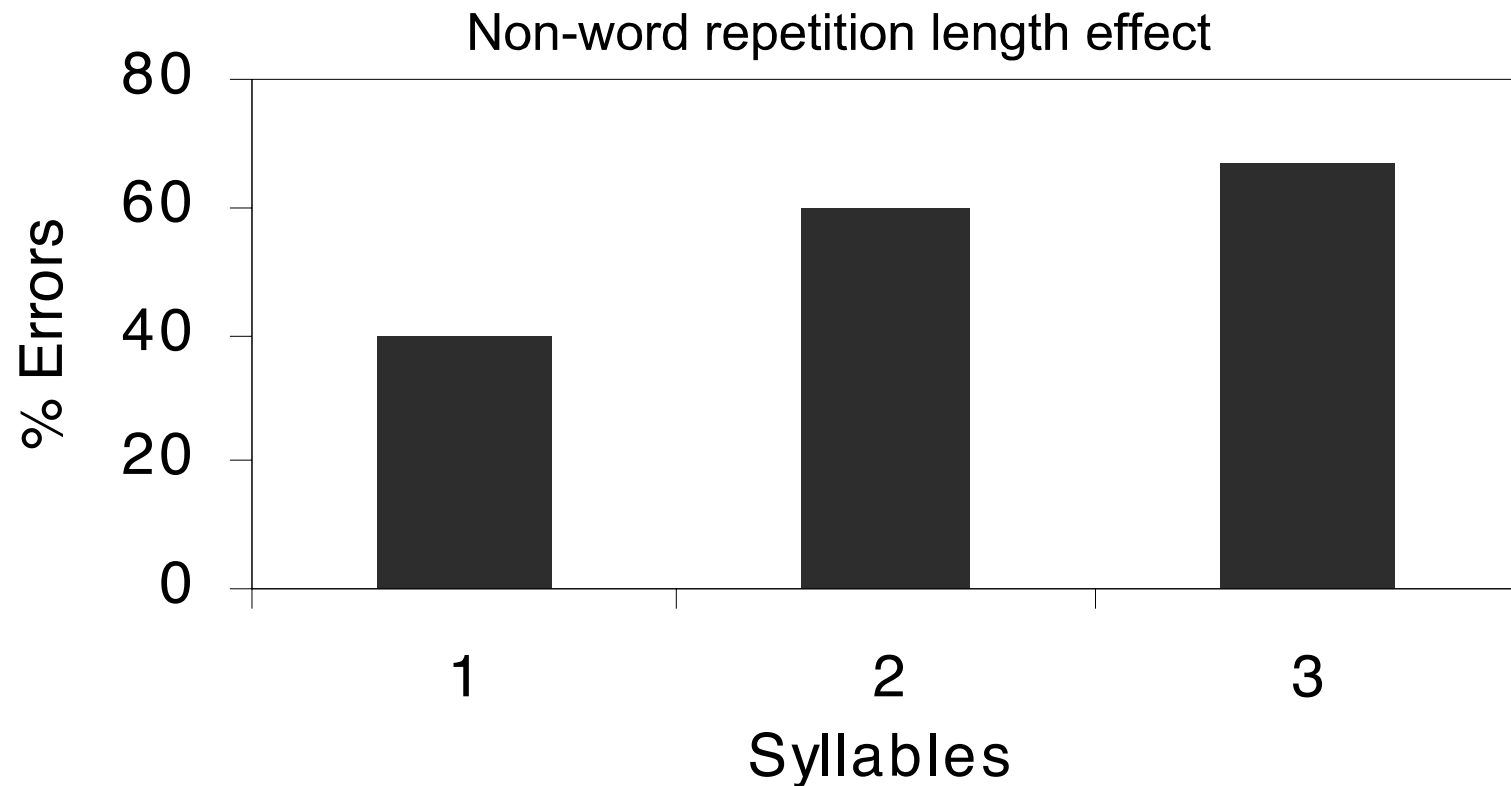
Is RC's Performance a Lexical Effect?

Non-words bypass the lexical route in production.
Hence, similar error patterns in words and non-words
would exclude a lesion in the lexical system



RC - Non-word repetition

RC's non-word repetition just like word repetition exhibits a length effect and a concentration of errors at the beginning of a word.



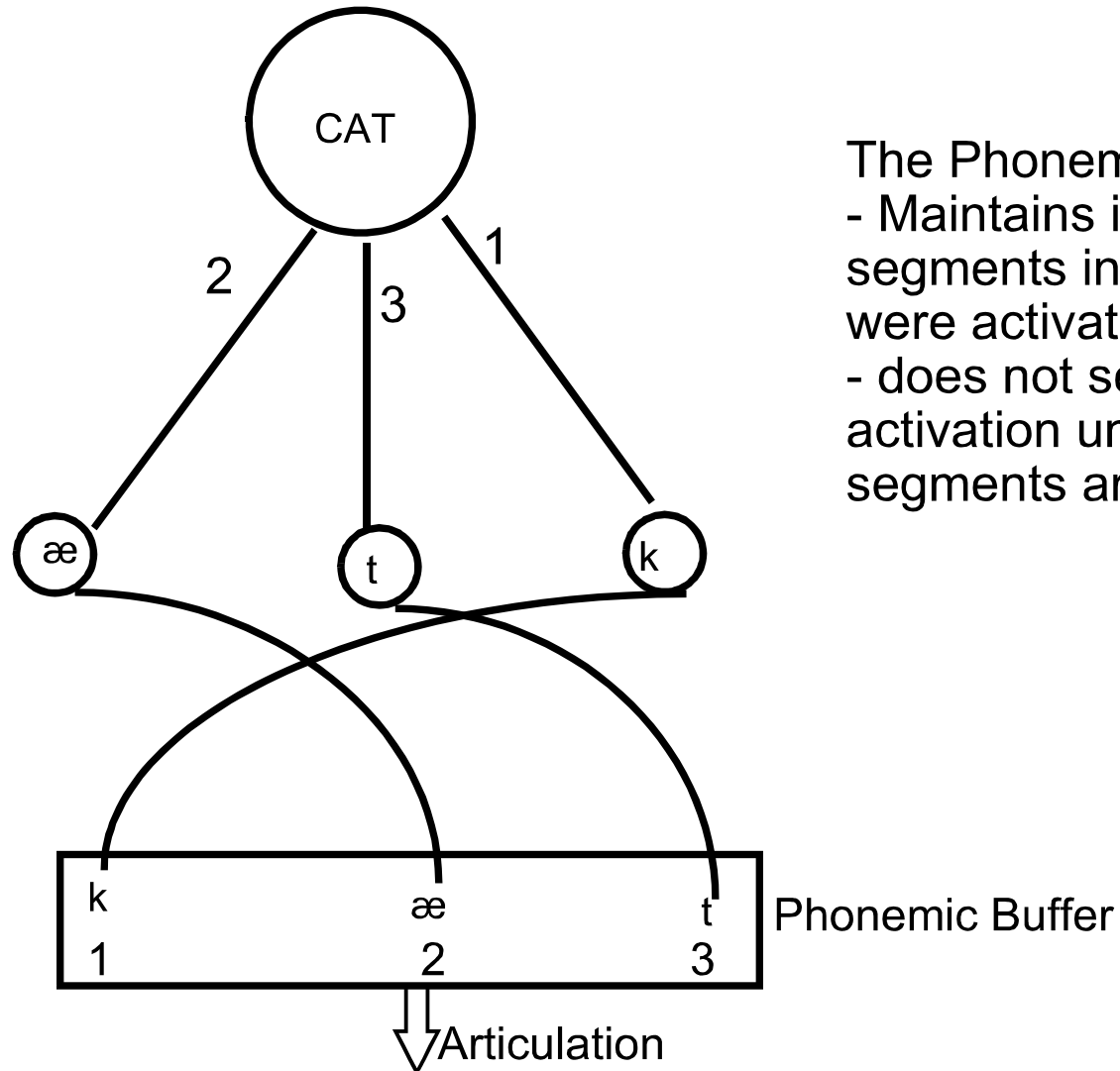
RC- Examples of Non-Word Errors

farsty	thirsty
footh	truth
junkle	chunkle
putton	cotton
shreedom	freedom
truckle	prukkle

RC Errors are a result of a lesion in the Phonological Buffer

- Picture Naming Performance is evidence against an Input Lesion
- Non-Word Performance is evidence against a Lexical system lesion
- Position and length effects for words and non-words suggest a lesion in the late phonological system -the Phonological Buffer

The Phonemic Buffer Repeated



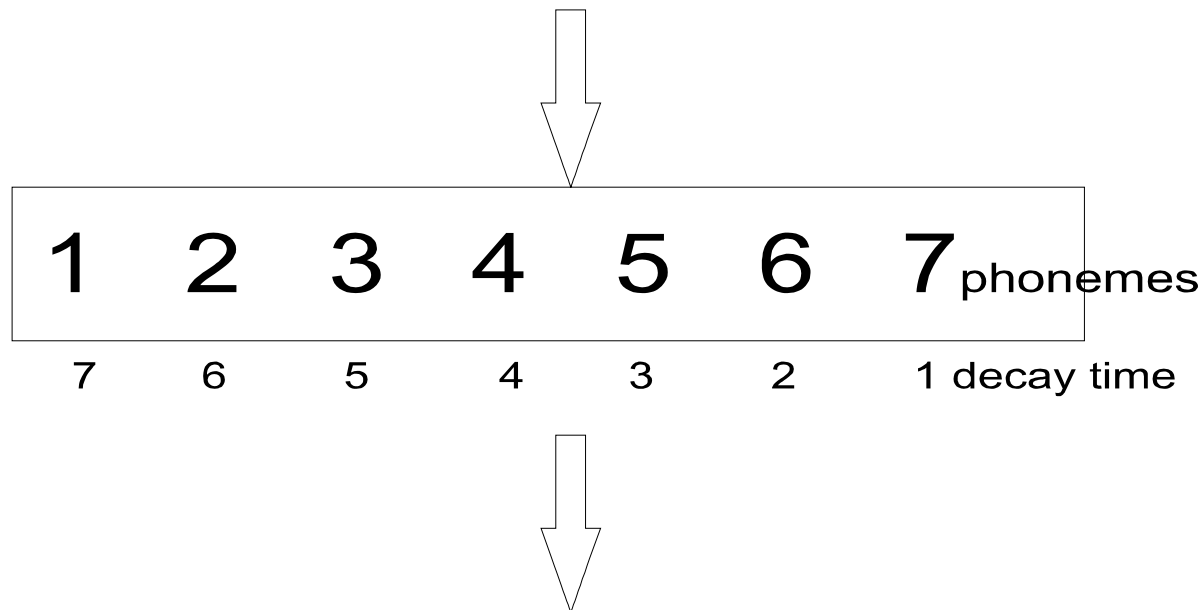
The Phonemic buffer:

- Maintains in memory segments in the order the were activated
- does not send any further activation untill all the segments are processed

Linearization buffer

What will happen if there is a lesion in the buffer?

- Length effect: Longer words will be harder to process since they will have more time to decay
- Position effect: Segments at the beginning will decay more since they will be stored longer

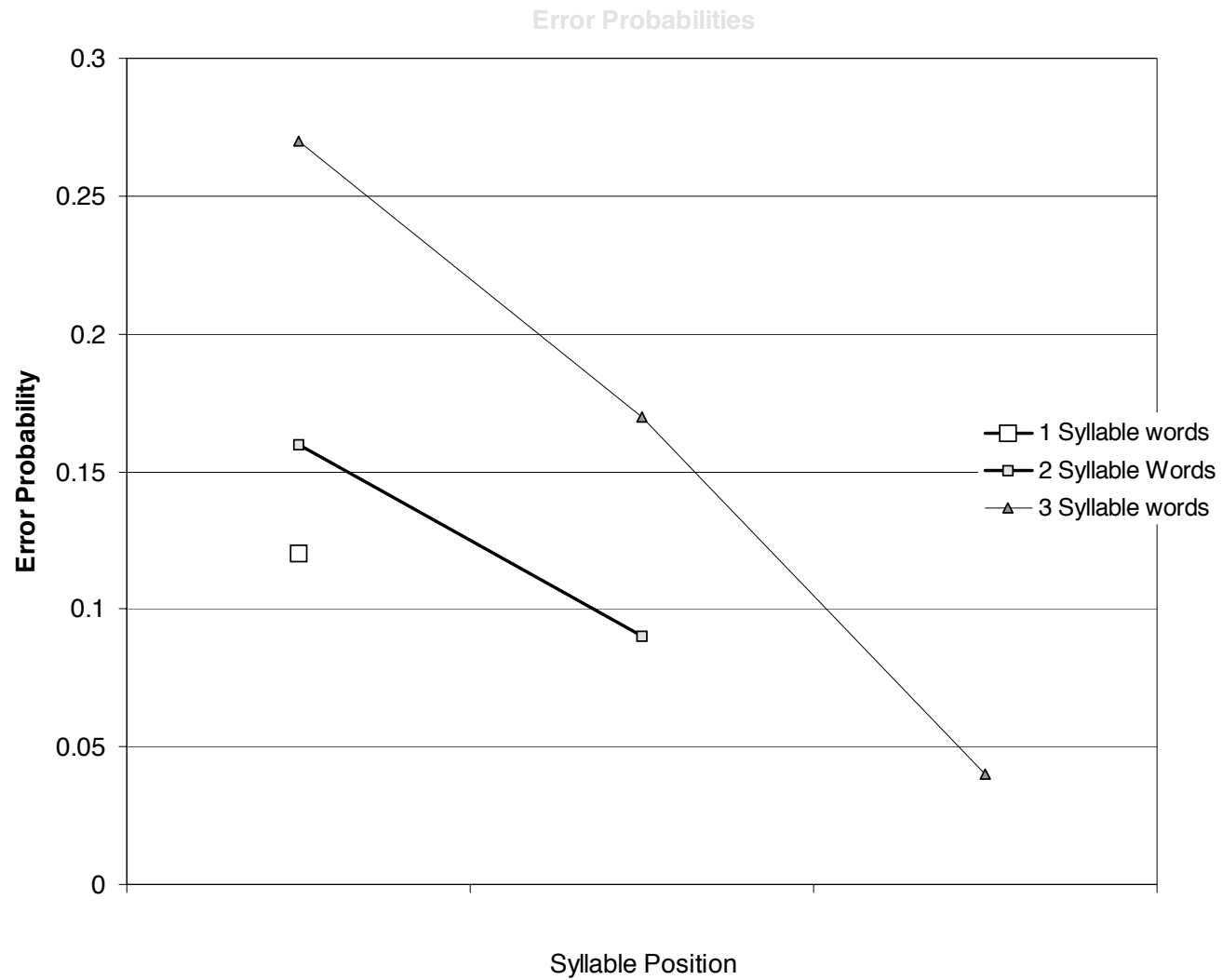


Predictions to a lesion in the Phonemic Buffer

- This predicts that the amount of errors on the first syllable of a two syllable word should be identical to the amount of errors on the second syllable of a three syllable word



Error Predictions



Positions Effects due to word initiation problems

A possible hypothesis for RC's problems at the beginning of words is that he has problems with initiating speech.

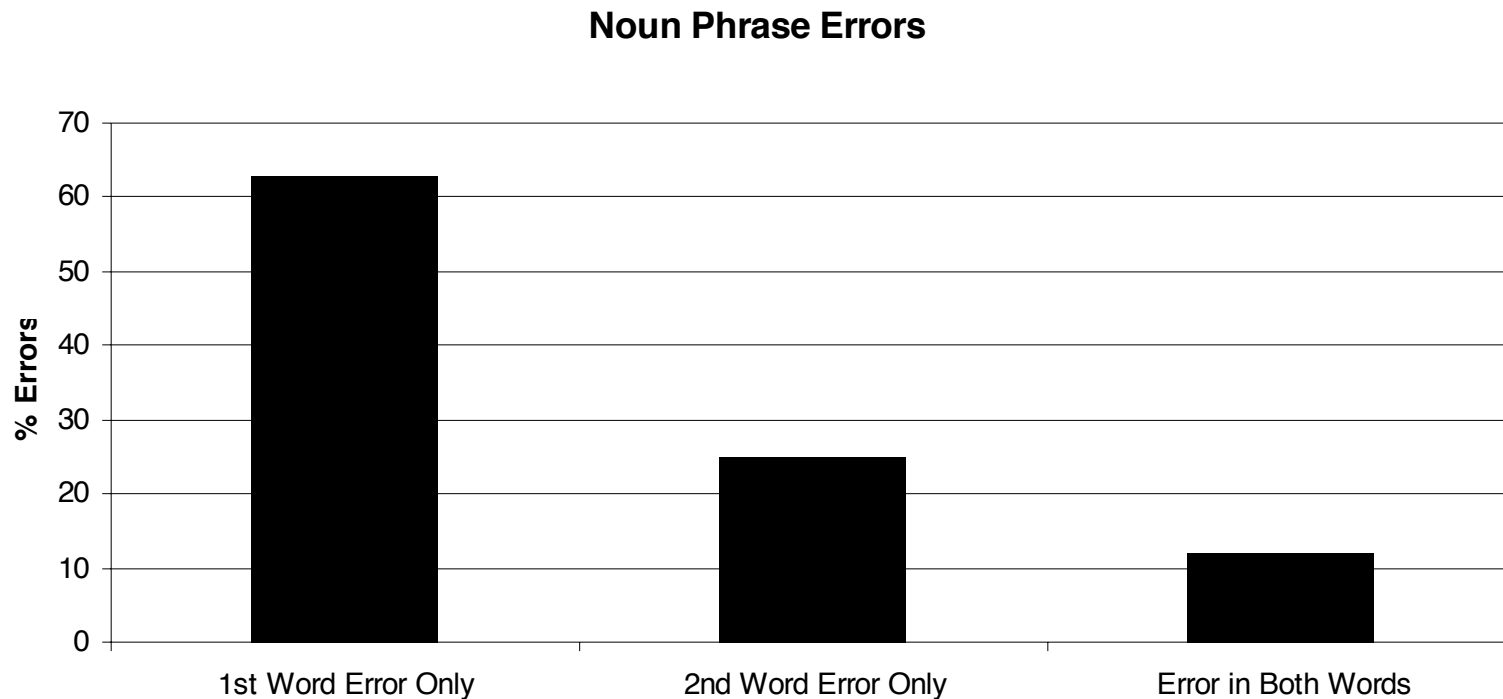
To test this we asked him to repeat more than one word at a time on the assumption that if it is an word speech initiation problem his errors should be evenly spread among both targets.

The domain of RC's errors - word or phonological word?

- Tests involving repetition of phrases and compound words indicate that RC makes errors at the beginning of a larger prosodic unit than a single word.

RC - Adjective + Noun repetition

In Adjective plus Noun Repetition RC makes more errors on the first word. Most of these errors are at the beginning of the word

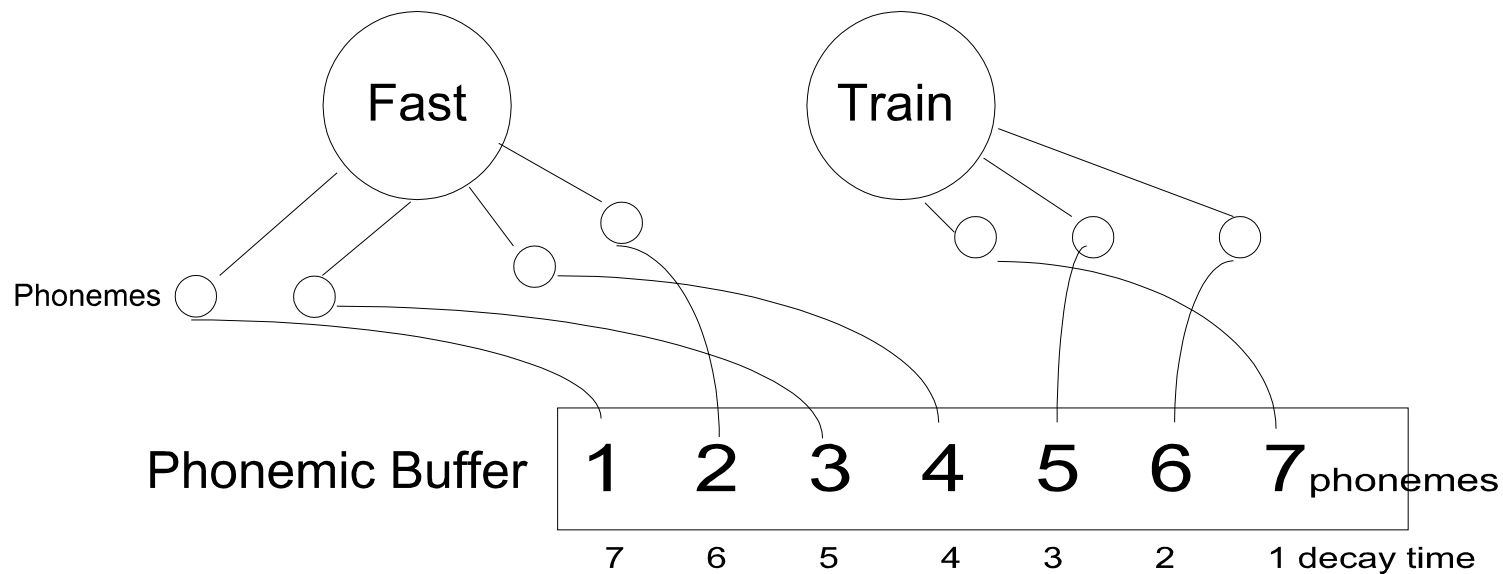


RC - Examples of NP Repetition Errors

flannel towel		fannel towel
fearless lion		fearlest ion...lions
dead goat		gedgoat
sliced bread		lice bread
fast train		last train

Multiple Words in the buffer

- Phonemes are inserted into the buffer in the order they are going to be produced.
- The buffer does not send any activation until all the phonemes are inserted and linearized.
- Thus, segments at the beginning of a word decay most and are most susceptible to errors.
- The phoneme buffer is not limited in size to single words

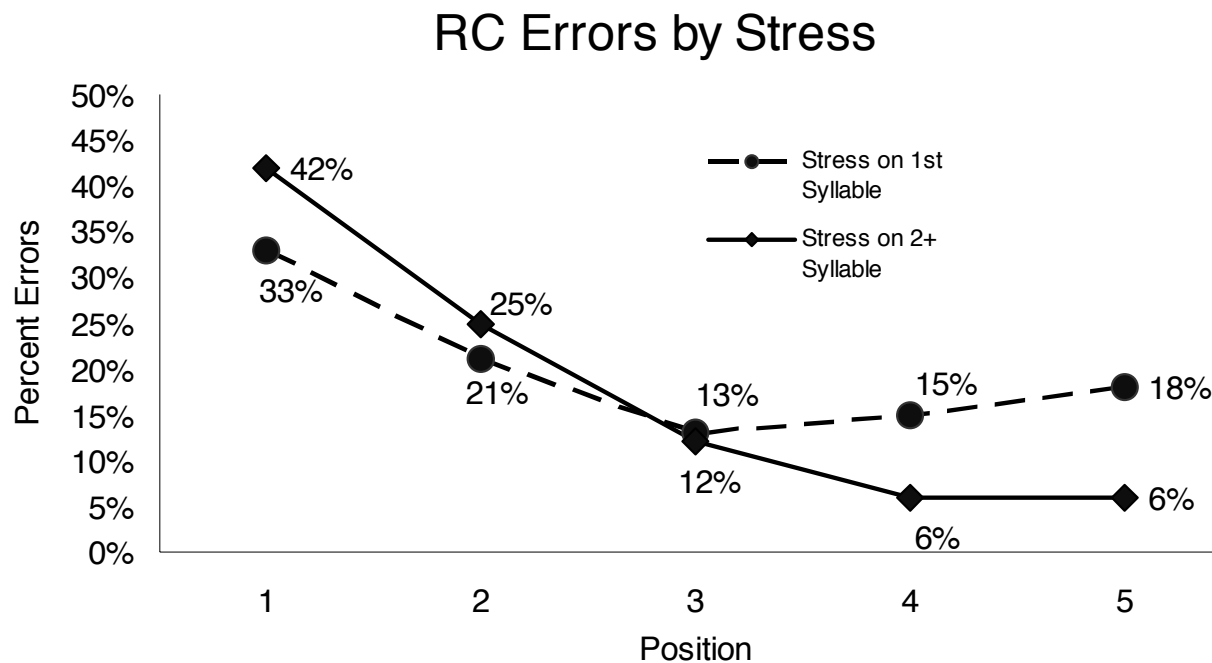


Summary

- A study of RC's errors has allowed us to postulate a detailed mechanism of phonological encoding that includes a phonological buffer that:
 - ▶ Maintains the linear order of segments
 - ▶ Is length sensitive
 - ▶ Holds in memory more than one word
 - ▶ Holds non-word segments

RC- word initial errors and stress

Stressed Syllables are less likely to have errors in RC



Stress is not computed on-line

- If we assume stress is computed in the phonemic buffer then we cannot assume that this buffer can process more than one word.
- Thus we will assume that stress is an inherent lexical property of lexical items.
- How can we then account for the interaction of stress and error rate?

What other information is processed in the Phonemic Buffer?

- The phonemic Buffer:
 - Assigns linear order to segments
 - Processes words and non-words
 - Is insensitive to grammatical information

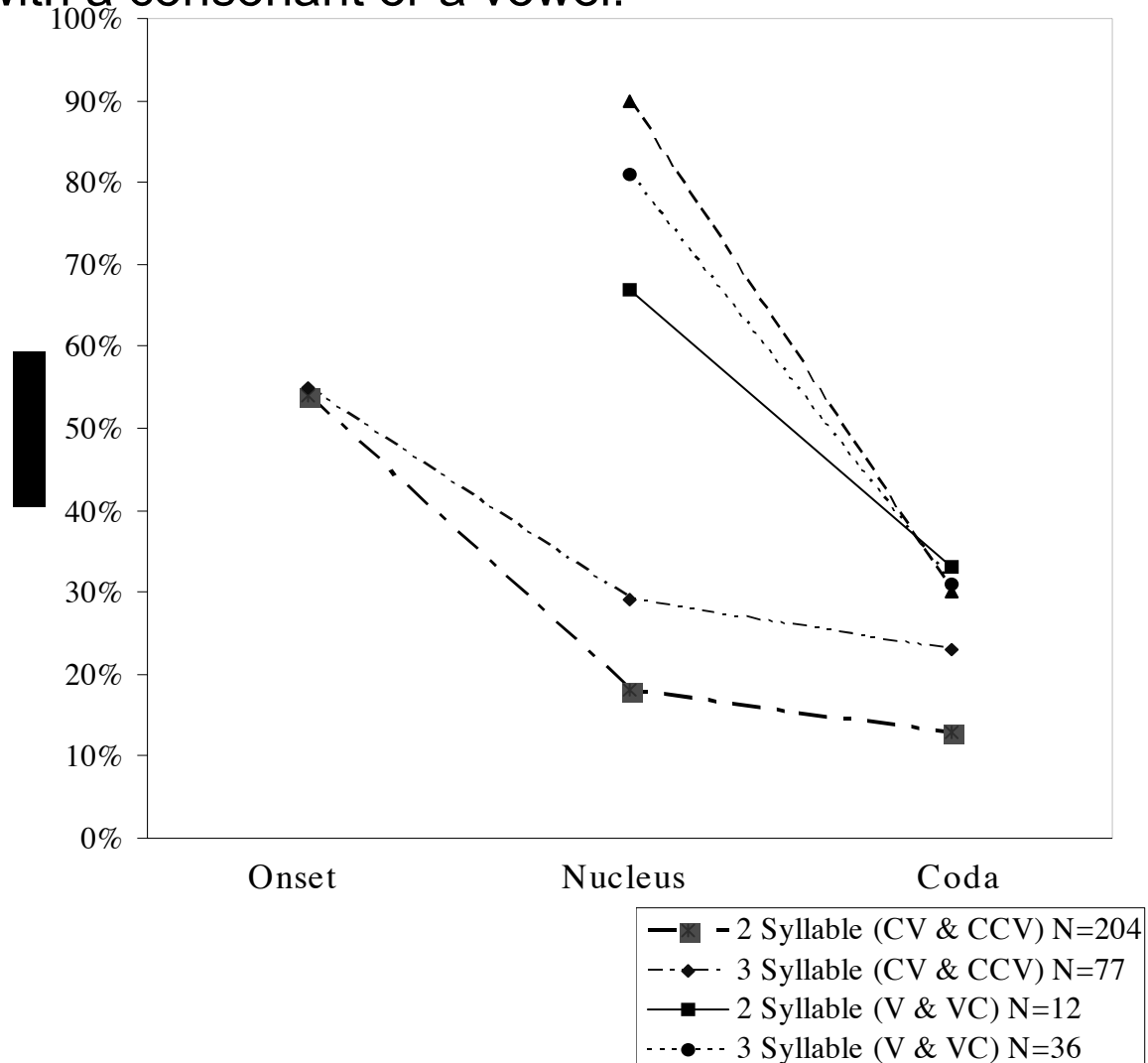
Stress as additional activation

- The facilitatory effect of stress on production can be accounted for if we assume that stressed syllables have larger phoneme activation in the buffer and thus are less prone to decay.



Word initial errors - type of word onset

- The occurrence of word initial errors is irrespective of whether the word begins with a consonant or a vowel.



Word initial errors do not result in syllable simplification

- RC's does not perform more errors in words that have complex syllable structure
- His output does not result in a simplified syllable structure.

Syllable Structure Repetition

Total	N	# Correct	% Correct
	401	278	69%
Syllable Structure	N	# Correct	% Correct
CCV.CCVC	12	9	75%
CCV.CV	15	10	67%
CCV.CVC	70	47	67%
CCVC.CV	20	17	85%
CCVC.CVC	53	37	70%
CV.CCV	22	19	86%
CV.CCVC	58	36	62%
CVC.CCV	56	39	70%
CVC.CCVC	67	41	61%
CVC.CV	28	22	79%

RC Compound Word Repetition

Compound Word Repetition Task			
	Target	Type	Response
1	blueberry	L	blueberries
2	sunglasses	L	kunglasses
3	outnumber	L	number
4	pigheaded	L	pigidhead
5	flyswatter	L	ss-, x2, x3 slyfauter
6	trustworthy	L	tussworthy
7	pincushion	L	x2, pinpushin
8	sunbathing	L	x2, tungbathing
9	buttercup	R	gutterputt
10	hummingbird	R	hummingbirds
11	poppyseed	R	poppyseeds
12	expressway	R	pressway
13	runway	S	oneway
14	raindrop	S	raindop
15	downpour	S	townpour

N		T y p e	
	1 7	1 0	L
	1 7	4	R
	1 7	3	S
Left small			
first word	7		
second word	1		
Right side small			
first word	2		
second word	2	(affix addition)	
Same			
first word	2		
second word	1		

A compound repetition task where compound words were controlled for their length (L - left longer, S- same, R -right longer) revealed that RC made more errors when the second compound was longer. The errors were mostly on the first part of the compound (10/17)

RC compared to a 'standard' patient JR

- RC's performance compared to that of a patient (JR) who exhibits a 'typical' distribution of errors indicates that RC's performance is a mirror image of typical errors as far as position is concerned.

R C & J L R R e p e t i t i o n C o m p a r i s o n :
S i n g l e W o r d s a n d N o n - w o r d s

