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2004

## Investigating the phonological similarity effect: implications for short-term memory models

Lisa M. Nimmo  
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# **INVESTIGATING THE PHONOLOGICAL SIMILARITY EFFECT: IMPLICATIONS FOR SHORT-TERM MEMORY MODELS**

A thesis submitted in fulfilment of the requirements for the award of  
the degree

DOCTOR OF PHILOSOPHY

From

UNIVERSITY OF WOLLONGONG

By

Lisa M. Nimmo

BPsych(Hons)

Department of Psychology

2004

# **CERTIFICATION**

I, Lisa M. Nimmo, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Department of Psychology, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Lisa M. Nimmo  
9<sup>th</sup> January 2004

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## **Abstract**

The current thesis examined the effect that phonological similarity has on short-term memory (STM) performance. Across nine experiments, the predictions that two classes of STM models (non-linguistic and psycholinguistic) generate for the effect that phonological similarity has on the recall of item information and memory for an item's position in a list were tested.

In the current thesis, phonological similarity was operationally defined in a number of different ways. For instance, lists of consonant-vowel-consonant (CVC) words and nonwords, rhymed (shared \_VC component), shared the initial consonant and vowel (CV\_ component) or shared the two consonants (C\_C component). Performance across these conditions was compared to when the stimulus lists were either phonemically dissimilar (i.e., used as a baseline measure of performance) or phonemically similar (i.e., each stimulus in each list had at least two phonemes in common with at least one other stimulus in the same list).

Regardless of whether the experimental stimuli were words or nonwords, when performance was measured using the item recall criterion (scored as correct if a participant recalled an item that was presented in a list, regardless of position), an item recall advantage was observed for rhyming lists of stimuli. Non-linguistic STM models suggest that an item recall advantage should be observed whenever the size of the 'secondary memory search set' can be limited to a smaller number of items (e.g., all items that rhyme). In contrast, psycholinguistic models of STM assume that this item recall advantage derives from sub-syllabic structures that aid the recall of item information.

In terms of the effect that phonemic similarity has on order memory, the findings from the current thesis are inconsistent with the predictions generated from non-linguistic models of STM that are based on the distinctiveness assumption – the idea that as similarity increases order memory should decrease. Rather the findings are consistent with psycholinguistic models of STM that assume that the effect that phonemic similarity has on order memory is a consequence of linguistic constraints, such as sonority, that operate at the sub-syllabic as compared to lexical level. Based on the current research findings, modifications to existing STM models have been proposed.

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## Preface

Chapter 4 of this thesis has been published as part of a jointly authored paper:

Nimmo, L.M., & Roodenrys, S. (in press). Investigating the phonological similarity effect: The Syllable structure and the position of common phonemes. *Journal of Memory and Language*.

Chapter 5 of this thesis is currently under review as part of a jointly authored paper:

Nimmo, L.M., & Roodenrys, S. (submitted). Investigating the phonological similarity effect: Are nonwords an alien form? *Journal of Experimental Psychology: Learning, Memory, and Cognition*.

Chapter 6 of this thesis is currently under review as part of a jointly authored paper:

Nimmo, L.M., & Roodenrys, S. (submitted). The phonological similarity effect in serial recognition. *Memory*.

For all three manuscripts, I designed the experiments, created the stimulus lists, programmed the experiments, recruited participants, collected and analysed the data, and prepared the manuscripts.

Parts of the research in this thesis were presented at: *The 30th Annual Conference of the Australasian Experimental Psychology Society*, University of Western Sydney, Sydney, NSW, Australia, April, 2003. *The Quebec'02 Conference on Short-term/Working Memory*, Quebec City, Canada, July, 2002. *The 6th Conference of the Australasian Cognitive Science Society*, Freemantle, Western Australia, April, 2002.

## Synopsis

The effect that phonological similarity has on our ability to recall items from short-term memory (STM) is one of the theoretically most influential findings in studies of STM: This is the finding that serial recall performance is worse if words sound similar to each other (e.g., Conrad & Hull, 1964). However, when performance was measured for item recall (i.e., number of items recalled, regardless of position), Wickelgren (1965d) found no differences between phonemically dissimilar and similar lists of items. This led earlier researchers to conclude that phonological similarity influences the order in which items are recalled rather than the retention of item information (Murdock, 1976).

The effect that phonological similarity has on a participant's ability to recall list items in the correct order is such a robust finding in the STM literature that some researchers have suggested that the value or worth of extant STM models can be gauged by the explanations they generate for this effect (Gathercole, 1997; Nairne, 1990a; Page & Norris, 1998). As Nairne and Kelly (1999; p.45) suggest,

*“...the phonological similarity effect has achieved the status of a ‘benchmark’ finding in the immediate memory literature, and most theories of short-term memory include mechanisms that are specifically designed to account for the phenomenon”*

However, recent research findings have questioned the stability of the phonological similarity effect. Although the detrimental effect that phonological similarity has on order memory has been replicated in numerous studies (e.g., Baddeley, 1966), when the effect that phonological similarity has on the recall of item information is examined, the results are contradictory. For instance, although some studies have found no differences between phonemically similar as compared to dissimilar lists of items (e.g., Poirier & Saint-Aubin, 1996), others have found that phonemic similarity can either facilitate (e.g., Fallon, Groves & Tehan, 1999) or have a detrimental effect (e.g., Coltheart, 1993) on the recall of item information.

A number of suggestions have been proposed to account for the contradictory findings that have recently been observed in the research literature. For instance, according to Fallon et al., (1999) differential results are observed in the literature depending on how phonological similarity has been operationally defined, the size of the word pools used to construct the stimulus lists, and the scoring criteria (i.e., correct-in-position, item recall, or order accuracy) used to measure STM performance.

In light of the inconsistencies that have recently been reported in the research literature, a major aim of the current thesis was to examine the effect that operationally defining similarity in different ways has on the recall of item information and memory for an item's position in a list. This was achieved by constructing lists of consonant-vowel-consonant (CVC) items that either shared the rhyme (\_VC), the initial consonant and vowel (CV\_), or the two consonants (C\_C). Thus, the position of the overlapping phonemes was manipulated, while the amount of phonemic overlap (as measured by the degree of shared consonant and vowel information) was held constant. Performance on these types of lists was compared to when the stimulus lists were composed of either phonemically similar (i.e., each stimulus in each list consisted of at least two phonemes in common with at least one stimulus in the same list) or phonemically dissimilar (i.e., no item in a list shared any common phonemes with any other item in the same list) items.

A further aim of the current thesis hinged on the idea that "...any plausible model of short-term memory must explain" the phonological similarity effect (Lian, Karlsen & Winsvold, 2001; p.281). Currently, there are two distinct classes of STM models that attempt to provide an explanation for the effect that phonological similarity has on STM performance: psycholinguistic and non-linguistic models of STM. Psycholinguistic models of STM (e.g., Gupta & MacWhinney, 1997; Hartley & Houghton, 1996) are based on the idea that the effect that phonemic similarity has on item and order memory derives from the influence that sub-syllabic linguistic mechanisms, such as syllable structure and sonority, have on STM performance. In contrast, non-linguistic STM models (e.g., Brown, Preece & Hulme, 2000; Burgess & Hitch, 1992, 1999; Nairne, 1988, 1990a, 2002) are based on the distinctiveness assumption – the idea that as similarity increases order memory should decrease. Thus, according to these types of models, if phonological similarity is held constant across experiments, similar levels of order memory impairment should be observed. Hence, the current thesis was designed

to critically evaluate the utility of psycholinguistic and non-linguistic STM models by the explanations they generated for the effect that operationally defining similarity in different ways has on the recall of item information and memory for an item's position in a list.

The current thesis can be divided into three distinct sections, the first of which is three introductory chapters. Chapter one was designed to provide a broad overview of STM, how STM has traditionally been measured, and more general research findings related to the effect that both phonological similarity and lexicality have on STM performance. Chapter two was dedicated to describing the assumptions that STM models are based on, and more generally, the mechanisms that researchers incorporate into these models to account for a variety of STM research findings. The final introductory chapter (Chapter 3) critically examined the existing research into the effect that phonological similarity has on STM performance with a particular emphasis on the inconsistencies that have been found in the research literature and its relation to both the lexicality of the experimental items and the effect that overt speech production has on STM performance.

The second section of the current thesis consists of three experimental chapters. Each experimental chapter has been written in manuscript format<sup>1</sup> and are self-contained, in that they were designed to investigate different issues with respect to the effect that similarity has on STM performance (although all of the experiments were designed to examine the utility of STM models by the explanations they generate for the effect that phonological similarity has on STM performance). The aim of study one (Chapter 4 - Experiments 1 to 3) was to examine the effect that operationally defining phonemic similarity in different ways has on the recall of item information and memory for an item's position in a list when the experimental stimuli were words. Study two (Chapter 5 - Experiments 1 to 3) was designed to further examine this issue, but with nonwords as compared to words. This type of investigation is warranted in that to date, a number of STM models do not provide an explanation for the effect that the phonemic similarity of nonwords has on STM performance. This stems from the belief that

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<sup>1</sup> Please note that although the wording has not changed for the manuscripts that are either in press or under review, the format has been changed to make these manuscripts consistent with the format that has been used in the current thesis.

“...given that no adequate long-term representations are available for nonwords, the reconstruction process, for all practical purposes, is thought not to operate for these items” (Saint-Aubin & Poirier, 2000; p.333). Finally, Gathercole, Service, Hitch, Adams and Martin (1999) have recently suggested that the findings observed from studies that require participants to verbally recall presented list items, may be influenced by an individual’s articulatory ability, especially when the experimental stimuli are nonwords. Hence, regardless of whether the experimental stimuli were words or nonwords, study three (Chapter 6 - Experiments 1 to 3) was designed to examine the effect that phonemic similarity has on order memory, once the demands that overt speech production have on STM performance are removed.

The final section of the current thesis consists of two concluding chapters. Chapter seven draws a number of clear conclusions that are based on the current research findings. Firstly, the findings from the current thesis suggest that the same mechanisms are involved both word and nonword recall. Secondly, that the effect that similarity has on order memory remains, once the demands that overt speech production have on STM performance are removed. Finally, that STM models that are based on the distinctiveness assumption (e.g., Nairne, 1988, 1990a) are unable to account for the current research findings. Rather, the findings are more consistent with the explanations that psycholinguistic models of STM (e.g., Gupta & MacWhinney, 1997; Hartley & Houghton, 1996) generate for the effect that phonological similarity has on the recall of item information and memory for an item’s position in a list. The current thesis culminates (Chapter 8) with an in-depth discussion of the implications that the current research findings have for extant STM models with a particular emphasis on modifications to existing STM models and suggestions for future research.