# AGE-RELATED DIFFERENCES IN VERBAL, VISUAL AND SPATIAL MEMORY: The Same or Different?

Thesis submitted by

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# DECLARATION ON ETHICS

The research presented and reported in this thesis was conducted within the guidelines for research ethics outlined in the *National Statement on Ethics Conduct in Research Involving Human* (1999), the *Joint NHMRC/AVCC Statement and Guidelines on Research Practice* (1997), the *James Cook University Policy on Experimentation Ethics. Standard Practices and Guidelines* (2001), and the *James Cook University Statement and Guidelines on Research Practice* (2001). The proposed research methodology received clearance from the James Cook University Experimentation Ethics Review Committee (Approval numbers: H1718, H1947 and 2137).

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# ABSTRACT

Working memory comprises a number of components, each responsible for the processing of different types of information. The phonological loop is responsible for processing verbal information while the visuo-spatial sketchpad is responsible for processing visual and spatial information. Age-related differences in verbal working memory are well documented with older adults consistently shown to have shorter memory spans than younger adults. Declines in spatial memory have also been reported. The data for visual memory performance however is less clear, with some researchers reporting decline across the adult lifespan and others reporting no difference. The purpose of the current thesis was to examine performance on a number of verbal, visual and spatial memory tasks in an effort to determine whether each type of memory declined with increased age and if so, whether they were affected by age to the same extent. Three studies were conducted to achieve these aims.

The first study explored the role of articulatory suppression, which has been shown to disrupt performance on verbal memory tasks; the effect on visual and spatial memory tasks is not so clear however. Fifty university undergraduates (12 men, 38 women) aged between 18 and 53 years (*M* = 24.38; *SD* = 8.62) completed verbal, visual and spatial memory tasks of differing memory set sizes under suppression and no suppression conditions in Study One. Results show that performance on all the tasks at each set

size was significantly affected by concurrent verbal suppression. It was concluded that articulatory suppression prevents participants from verbally encoding visual and spatial stimuli, leaving them to rely on purely visual or spatial representations. As a result articulatory suppression may provide researchers with an effective means to examine these types of memory with minimal contributions from the verbal system.

Study Two examined the reliability and validity of nine working memory tasks. One hundred and two first and second year psychology undergraduates aged between 18 and 56 years (*M* = 23.96, *SD* = 9.78) completed three verbal, three visual and three spatial working memory tasks. Seventy-three of these participants returned for retesting 14 days later. Results show that the test-retest reliability of the tasks was adequate to good with reliabilities ranging from 0.51 for letter orientation to 0.89 for the arithmetic task. Three factors, interpreted as verbal, visual and spatial factors, emerged from the data, accounting for a total of 58.8% of the variance. The tasks, with the exception of letter orientation, appeared to be reliable and valid indicators of the constructs they were designed to measure and were therefore used in Study Three of the current thesis. However, it is suggested that the psychometric properties of the tasks be examined in additional and preferably larger samples and using a smaller memory set size and different age groups.

Study Three examined age-related differences in verbal, visual and spatial memory using all of the tasks from Study Two except for letter orientation.

Letter orientation was replaced with a letter location memory task, which was similar in design to the dot memory task used in Study Two. Two hundred and one university undergraduates and community dwelling residents aged between 18 and 80 years, 139 females and 62 males (*M* = 44.95; *SD* = 21.08) completed three processing speed tasks, three verbal, three visual and three spatial memory tasks. Results of a 3 (task: verbal, visual, spatial) × 3 (age group: young middle, older) mixed ANOVA with Bonferroni corrected comparisons revealed that there were no significant differences between young and middle aged adults performance on the verbal, visual or spatial memory tasks. Significant differences were revealed between the young and older adults' verbal and spatial memory performance but not for visual memory performance. The differences between the middle and older age groups' verbal, visual and spatial memory scores were significantly different.

The relationship between age and each type of memory was examined using a series of regression analyses. The first, using age as a predictor of each type of memory, showed that age explained a significant amount of the variance in verbal (11%), visual (3%), and spatial (16%) memory. After controlling for processing speed, the amount of age related variance on each type of memory decreased (verbal 5%, visual 0.08% and spatial 9%). Speed acted as a partial mediator of verbal memory variance and a full mediator of visual memory variance but not of spatial memory variance. Regression models using age, number of medications and processing speed explained a significant 15% of the variance in verbal memory, 17% of the visual memory variance and 17% of the spatial memory variance. Age made significant contributions to verbal and spatial memory variance but not to visual memory variance. Processing speed made significant contributions to the variance in verbal and visual memory but not in spatial memory. The number of medications taken per day was the strongest contributor to visual memory variance.

Because the *n*-back tasks used in this study may have been tapping central executive processes, further models were examined using these tasks as a central executive variable along with age, number of medications, and processing speed. The results of these analyses revealed that the model explained a significant 36% of the variance in verbal memory, 32% of the visual memory variance and 28% of the spatial memory variance. The central executive variable was the strongest contributor to the variance in verbal memory (25%) and visual memory (11%); however age remained the strongest contributor to spatial memory variance (12%). Processing speed no longer made a significant contribution to verbal memory variance when the central executive variable was included in the model.

It was concluded that verbal, visual and spatial memories do decline with age but only after middle age; there appears to be little difference between young and middle aged adults. It was also concluded that verbal, visual and spatial memories are differentially affected by age with age explaining more of the variance in spatial memory than in verbal and visual memory. Age does make a significant contribution to verbal memory variance but it is not a significant predictor of visual memory performance. Hence, the decline in visual memory performance after middle age is not age-related but appears to be related to other variables such as the number of medications a person takes each day and to the efficiency of central executive functioning. The relationship between verbal, visual and spatial memory performance and processing speed is also not the same across the lifespan, with processing speed mediating the variance between age and verbal and visual memory, but not spatial memory. Finally, it appears that the central executive plays an important role in performance levels on each of the different types of memory but not to the same extent in each subsystem.

# TABLE OF CONTENTS

# LIST OF FIGURES

# LIST OF TABLES