

# **LANGUAGE IN INDIA**

**Strength for Today and Bright Hope for Tomorrow**

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## **Speed of Processing in Adults Comparison across Grammatical Category**

**Deepa N Devadiga, MASLP, Radish Kumar B, M.Sc.,  
Jayashree S. Bhat, Ph.D., and Livingston Sengolraj, UG Student**

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### **Introduction**

Lexical items are alienated into different word classes, such as nouns and verbs, as they play different semantic and syntactic roles in language. They are responded to differentially by language users in behavioural tasks. Nouns and verbs are retrieved by different neural networks thereby honouring an organizational principle (Damasio and Tranel, 1993).

### **Evidences for the Differential Lexical Organizations**

A major line of evidence for the differential lexical organization of verbs from nouns has primarily come from the grammatical class - specific impairments resulting from brain damage. Earlier in 1961, Fillenbaum, Jones, and Wepman reported verb production impairments in Broca's aphasia followed by an overwhelming number of case studies reporting either selective noun or verb retrieval deficits (Shapiro, Shelton, & Caramazza, 2000; Laiacona & Caramazza, 2004).

The second evidence for the noun-verb difference comes from developmental studies. For instance, the vocabulary of very young children includes mainly nouns, compared to verbs that are present in a very limited number (Gentner, 1982).

### **Advantage for Nouns**

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The possible interpretation for this advantage for nouns compared to verbs lies in the greater conceptual complexity of verbs compared to nouns. The lesser complexity of nouns leads to the earlier acquisition of the names for nouns than for verbs (Gentner, 1982). The categories for nouns are more natural than those for verb. They often refer to the perceptual properties that tend to cohere and form natural conceptual categories. Though there are conflicting evidences on the anatomical locus of verb retrieval skills in the brain, in general, it is evident that either nouns or verbs could be differentially impaired following brain damage, reflecting the possible differences either in the organization and or processing of these two grammatical classes of words.

### **Aging – A Major Factor**

Numerous cognitive and biological changes occur during healthy aging. Older adults report that one of their most annoying cognitive problems is the inability to produce a well-known word (Rabbitt, Maylor, McInnes, Bent & Moore, 1995). At the cognitive level, these changes include decline in functions such as episodic and working memory, attention and inhibition (Salthouse, 1996). The speed of all components of processing from selective attention to responding declines with aging. It becomes even more apparent as the complexity of the processing demands increases. Bashore et al., (1997) findings suggest that speed of processing differs between young and older adults because they adopt different performance strategies.

Damasio and Tranel (1993) study posited a theory of separate lexical mediation systems for concrete nouns and verbs. This theory was validated after the detailed examinations of the three patients with selective naming deficits. Two patients had lesion localized to left anterior/middle temporal with selective noun retrieval deficits, and third had a lesion in the left frontal region with a selective verb retrieval deficit. All other functions were normal for the three patients. Damasio and Tranel (1993) noting the correspondence between lesion location and overt behaviour, argued that there are separate neuroanatomical systems for noun and verb retrieval. Daniele et al. (1994) summarized the findings of several studies that compared patients on naming performance and lesion location and found converging evidence to implicate the left frontal lobe in verb retrieval and the left temporal lobe in noun retrieval.

### **Age-related Decline**

With advancing age, cognitive functions may remain stable or decline. An average incidence rate of cognitive decline of 12 to 15 per 1000 persons –years has been reported for people 65 years and older (Ganguli *et al.*, 2000) in India. Cognitive functions that decline include selective attention, naming of objects, verbal fluency, complex visuospatial skills and logical analysis. Age related decline in cognitive domains such as memory is well documented ( Craik and Salthouse, 1999). In particular, older group often experience more difficulties than younger adults on memory tasks with high demands on control processes (Moscowitch and Winocur, 1995). Adults, who often have more difficulties on tasks with high demands on cognitive control, would show a selective underactivation compared to young adults.

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More studies find evidences for an increase in word finding difficulty with age (Au et al., 1995). Heller and Dobbs (1993) found that older adults were less accurate and exhibited greater uncertainty than young adults. The retrieval of nouns and verbs declines progressively with age (Anna, Lisa, Martin and Loraine, 2002). Evidence from a variety of sources suggests that the language processing system includes at least some components that discriminate between nouns and verbs at the cortical level. Researchers studying healthy aging populations (Barresi et al., 2000) have noted a dissociation between performance on the Action Naming Test (ANT) and the Boston Naming Test (BNT) in their examinations of lexical retrieval failures in older adults. But, confrontation naming for objects and actions differs based on the comparison of performance on these two instruments.

## **Neural Correlates**

Electrophysiological studies in humans reveal neural correlates of the processing speed deficit hypothesis and its impact on cognition. These studies have focussed on changes in the peak latency of the P300 component of the Event Related Potential. Event Related Potential is thought to reflect processing which is involved in attention and memory operations; it is typically evoked by random and infrequent targets (Sutton, Baren, Zubin, & John, 1965). Neurological substratum related to executive functioning (prefrontal cortex and its circuitry) has been proposed as the neuropsychological base of cognitive flexibility. Kumar et al., (2010) investigated the cognitive flexibility in children with learning disability and found that they require more time to shift their cognitive set in response to changing stimuli when compared to typically developing children. There is an extensive evidence that the P300 latency is delayed in older adults, thereby providing an evidence of neural slowing during cognitive operations (Kok, 2000). EEG studies have also shown that earlier Event Related Potential markers of visual processing exhibit slowing in older adults. In these studies, hypothesis is that there is significant latency difference with respect to normal aging.

From the review of literature, it is clear that geriatrics is slower to process information compared to young adults. This slowing affects processing in all cognitive domains, not just language. If language difficulties are the result of slow processing speed, then individual differences in reaction time (RT) measures across the grammatical category should be predictive of variation within language ability. Hence the aim of our study was to assess the word retrieval for nouns and verbs in young adults and geriatric population.

## **Method**

### ***Research Participants***

Participants for the study were 20 young adults (10 males, M=19.3years, SD=1.2, range= 18-22; 10 females, M = 19.8 years, SD = 1.7, range= 18-22) and 20 geriatric (10 males, M = 74.4 years, SD = 5.1, range = 69-80) native Kannada speakers. All the participants were right-handed and did not have existing speech, language, hearing, neurological or psychiatric illness. All the participants were having normal or corrected-to-normal vision. Informed consent was obtained from all the participants before the commencement of study.

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## ***Experimental Procedure***

Experimental stimuli consisted of ten nouns and ten verbs in Kannada. All the words [nouns (cat, elephant, hen, eye, ear, apple, chair, broom, key, book) and verbs (writing, sleeping, standing, sitting, crying, dancing, bathing, running, sweeping, laughing)] were selected and incorporated only after obtaining familiarity rating by three native Kannada Speakers. These stimuli images were set in black outline on a white background and were presented through the laptop. A specially programmed DMDX software was used for the purpose. All the stimuli were inserted in a single list, and were randomly presented to the participants.

The software was programmed so that all the ten written word stimuli were automatically displayed on the screen one by one for 3500 msec. RT (the time interval between application of a stimulus and detection of a response) for each stimulus was measured. Only the vocal responses from the participants were recorded through Check Vocal software. The software automatically re-triggered to calculate the RT on the basis of an adjustable threshold. Participants were instructed to name the pictures immediately after it appears on the laptop screen as best and as short as they could. They were also told to avoid making a mistake, and also to avoid false starts, hesitation, articles or any other additional words.

## **Results**

The current study was carried out to assess the word retrieval for nouns and verbs in young adults and geriatric population.

Group	Gender	Category	Mean	Standard Deviation
Younger Group	Male	Noun	8.46	154.77
Younger Group	Male	Verbs	1.03	403.00
Younger Group	Female	Noun	9.40	99.13
Younger Group	Female	Verbs	1.04	111.35
Geriatric Group	Male	Noun	2.45	397.75
Geriatric Group	Male	Verbs	1.94	418.92
Geriatric Group	Female	Noun	1.48	381.14
Geriatric Group	Female	Verbs	1.51	227.18

Table 1 showing average latency time for the retrieval of nouns and verbs

As shown in Table 1, the younger male participants exhibited a mean reaction time of 8.46ms for nouns and 1.03ms for verbs and the younger female participants exhibited a mean reaction time of 9.4ms for nouns and 99.13ms for verbs whereas the geriatric male participants exhibited a mean reaction time of 2.45ms for nouns and 1.94ms for verbs where

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as the geriatric female participants exhibited a mean reaction time of 1.48ms for nouns and 1.51ms for verbs.

The results of the present study revealed significant main effect of the groups ( $f= 166.66$ ,  $p< 0.05$ ) indicating that geriatric participants were slower in processing both verbs and nouns in comparison to the young adults.

In terms of gender, among both the groups, the female participants processed faster for both the categories compared to males. The study revealed significant difference statistically ( $F= 22.196$ ,  $p< 0.05$ )

No significant main effect for verb and noun categories ( $F=0.462$ ,  $p>0.05$ ) was observed although nouns were processed faster than verbs in young adults and verbs were processed faster than nouns in the geriatric group.

It was also observed that the group gender interaction ( $F=30.9$ ,  $p<0.05$ ) was statistically significant. But there was no significant differences group and category interaction and gender and category interaction.

## **Discussion**

In the present study there were differences observed in the retrieval speed for the nouns and verbs. Differences in naming latencies reflect differences in cognitive processing during action and object naming. Longer reaction times in one of two similar tasks are believed to result from an additional cognitive step or demand needed for the slower task (Glaser, 1992).

This study indicated that geriatric individuals were slower to process both the nouns and verbs than the young adults. This could be attributed to regions in the brain showing differential recruitment for young adults and geriatrics when the requirements for selection of semantic information are high. These regions include left and right inferior frontal gyrus, left inferior temporal gyrus, and the angular cingulate cortex. Verbs have been described as more “relational” in their semantics than nouns (Genter, 1981; Langacker, 1987). Persson et al., (2004) have also opined that decreased processing speed during high selection verb generation is associated with increases in left inferior frontal gyrus activation in young participants but it decreases in older participants.

In language acquisition as well as psycholinguistic research, there is a long-standing debate on the so-called ‘noun bias’. Proponents of the noun-bias hypothesis assume that nouns are privileged in acquisition and processing of language, because they form ‘cohesive packages’ which are easily mapped onto words. Therefore, nouns should be processed faster than verbs as well as acquired before verbs. The nouns were processed faster than verbs in younger adult group in the current study which is in line with Marshall et al.,(1998) observation that the production of nouns is less impaired than the understanding and production of verbs.

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On the other hand, verbs were processed faster than nouns in geriatric group. Similar observations have been reported by Berndt et al., in 1997. This is also supported by the experimental observations on adults with selective disturbances of language which showed double dissociations between the impairment of one grammatical class with the other being spared, in both comprehension and production tasks, and in some, a selective impairment in verb processing only occurred (Caramazza & Hillis 1991; Daniele et al. 1994). However, some researchers have reported the opposite trend, with a selective deficit in noun processing (Daniele et al. 1994; Zingeser & Berndt 1990).

Positive correlations between reaction time and cortical activity in young adults and negative correlations between reaction time and cortical activity in senior adults in dorsolateral pre frontal cortex is reported (Rypma and D'Esposito, 2000; DLPFC, Reuter-Lorenz, 2001).

Older adults often experience more difficulties than younger adults on memory tasks with high demands on control processes (Moscovitch and Winocur, 1995). There is a growing consensus that the prefrontal cortex (PFC) undergoes anatomical and functional deterioration as a function of normal aging, and it has been proposed that dysfunction of frontal systems may underlie age-related cognitive decline (West, 1996; Raz, 1997).

The Anteriorcingulate cortex would be more involved in the verb generation task with high selection demands (multiple potential responses) than with low selection demands (one or few potential responses). In addition, age-related differences in activation in the Anterior Cingulate Cortex may reflect the failure of geriatrics to appropriately engage these cognitive control mechanisms. Additional activation was found in left anterior Pre Frontal Cortex for both young and senior adults and in the basal ganglia for senior adults.

Decreased speed may be related to less effective memory-scanning processes (Sternberg, 1966). The findings would suggest that senior adults may compensate for declining performance by the use of additional right homologous brain regions. The idea of compensation is supported by several neuroimaging studies in which right prefrontal recruitment in senior adults is associated with faster response times (Reuter-Lorenz et al., 2000, 2001) and higher memory performance (Cabeza et al., 2002).

Also, neuropsychological studies have shown that recovery of cognitive and motor functions after unilateral brain lesions may involve recruitment of homologous regions in the unaffected contralateral hemisphere (e.g., Buckner et al., 1996; Honda et al., 1997; Thulborn et al., 1999).

It was also observed in the current study that the female participants processed faster for both the grammatical categories compared to males. Various independent research studies have yielded controversial results as regards the effect of gender on reaction time. Noble (1964) noted that the males showed a shorter reaction time than females in every age group except 10 – 14 years and the oldest age group. In general, research seems to suggest that females have a higher regional cerebral blood flow than males (Kastrup et al., 1999). In females, it is up to 20% larger than in males, giving females better decision making and sensory processing skills. Females have demonstrated more frontal activation, compared to more parietal

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activation in males, during a mental rotation task (Weiss et al., 2003), and males have demonstrated a greater bias towards right hemisphere activation (and females to left hemisphere activation) during a task requiring a judgement of a whole object from its parts (Georgopoulos et al., 2001). Skandhan, Mehta, Mehta and Gaur (1980) reported that girls from the age of eight years and above have mental alertness superior to the boys of comparable age. The girls seem to have intellectual abilities, which are at least one to two years ahead of the boys. Venkatesh, Ramachandra, Suresh, Rajan (2002) observed that females had a longer reaction time when compared to males. Finally, females have also demonstrated a greater bilateral regional cerebral blood flow in temporal regions during performance of the Wechsler Memory Scale for memory recall (Ragland et al., 2000).

## Conclusion

The current study demonstrates that processing for nouns and verbs declines with age. The young adults had better reaction time for nouns compared to verbs, whereas for the geriatric group opposite trend was observed. Moreover the processing was faster among female participants compared to the male participants. The neural underpinnings of this behavior remain largely unknown. This study would advance our understanding of cognitive impairments among the healthy aging and the pathology with implications for the clinical practice. The findings can be strengthened by expanding on different lexical categories.

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