Selective and Divided attention span in younger and older adults

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May, 2016

CERTIFICATE

This is to certify that this dissertation entitled **"Selective and divided attention span in younger and older adults"** is a bonafide work submitted in part fulfilment for degree of Master of Science (Speech-Language Pathology) of the student Registration Number: 14SLP036. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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CERTIFICATE

This is to certify that this dissertation entitled "**Selective and divided attention span in younger and older adults**" has been prepared under my supervision and guidance. It is also been certified that this dissertation has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled **"Selective and divided attention span in younger and older adults"** is the result of my own study under the guidance of Dr.Abhishek B P., Lecturer in Speech Sciences, Department of SLS, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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Chapter I

Introduction

Cognition is defined as a set of mental abilities that are processed in the brain related to knowledge. The various cognitive processes include attention, memory, problem solving, decision making. All these cognitive processes are individual specific and variation in these processes can be seen across age. In our day to day life, we employ many cognitive processes. We indulge in several activities in everyday situations and they include these cognitive processes. In order to understand the information present in our surrounding, we need to be alert and conscious. This process is termed as attention and it is one of the major cognitive process that as activated in daily life. Ability of an individual to recall or recognize the information that was learnt or experienced is termed as memory, one of the cognitive processes. Cognitive processes tend to develop from childhood into adolescence, and decline at late adolescence. Older adults actually experience a great deal of stability in cognitive skills, along with growth or decline in others. Observable changes in cognitive tasks which include attention, memory, reasoning and sensory function provides a great evidence for age related changes in mechanism of cognitive aging. Wingfield (2000) states that, there may be deficits in older adults in information processing and that attributes to sensory loss or working memory limitations but not impairments in basic language capacities.

Sometimes problems may occur in our planning or in the environment which may lead to communication breakdown or any other critical situations, these problems are solved by higher cognitive processes like problem solving that in turn reason out the problem occurred and make an apt decision that help to overcome the breakdown occurred and leads to effective communication within ourselves or with the environment. Speech and language being the core element of every individual, these cognitive processes have their major contribution to this field as well. Memory and attention are identified to be the most important among the various cognitive processes.

Structural and functional changes in brain with respect to age is not uniform across the whole brain and even across the individuals, like wise age related cognitive changes differ across all cognitive domains or across all older individuals. Cognitive domains can be classified as basic cognitive domains which includes attention and memory whereas higher cognitive domains include speech and language, executive control and decision making. The basic cognitive functions most affected by age are attention and memory. Higher level cognitive functions include speech and language processing, decision making and also executive functions, which manage and counterpart the various components of the activities in need of cognition, may also be affected by age. Impairment of executive function is a major contributor to age related declines in a range of cognitive tasks. Complex tasks require decision making, problem solving, and planning of goal to the behaviors required work with integration and reorganization of information from varying sources.

In order to improve the efficacy of performance in higher cognitive level tasks, attention, speed of information processing and individuals ability to inhibit relevant information has a greater role. These cognitive functions overlap and interact with each other in many interesting and complex ways. These functions are reviewed separately below.

2.2 Basic cognitive functions:

Attention

Older adults show greater attention impairments on tasks that need dividing or switching of attention for multiple inputs or tasks. They show relative better maintenance of performance on tasks even though they are slower than young adults; distraction does not impair them differently as well. Adequate and independent performance in everyday life situations are highly influenced by attention deficits. The effects of practice, extended training under divided attention conditions may be an important remedial activity for older people.

Memory

Major cognitive domain that is studied across old aged individuals is memory. This domain has received more prominence in normal aging. Older adults often complain of increased rate of hike memory lapses as they grow old, and this acts as a major foundation for research to distinguish between memory decline with respect to normal aging and pathological aging. Unlike short term and working memory, long term memory requires retrieval of information from past which is no longer present or not been present in active state. The duration can be lasts from minutes to years ago. Retrieving and

encoding of such details in certain demanding situations may be taxing greater attention resources and greater cues which may be often lacking in older adults.

2.3 Higher cognitive functions:

Speech and language

Speech and language processing are largely intact in older adults under normal conditions, although processing time is likely to be more in young adults. Discourse skills actually improve with age. Older people often have structured detailed narratives that are more interesting than young individuals and judging those narratives are also curious. They usually have abundant vocabularies; even then they exhibit word finding problems at times which are most often masked by greater extent by circumlocutions. Good language skills are retained well into older age. Sensory loss or working memory limitations can be attributed to the deficits that occur under difficulty in processing and not the impairment of language alone.

Decision making

Decision making has a greater influence on attention and working memory processes. Their limitations might hamper the ability in decision making. Older adults most often rely upon expert opinions for decision making more often than younger adults. Poor decision making may also be a result of episodic memory decline, particularly the loss of memory for details or source.

Executive control

Executive control is an umbrella term that has a range of processes including planning, organization, coordination, implementation, and evaluation of many of our non -routine activities. Central executive has its major contribution in virtually all aspects of cognition, allocating attentional resources among tasks, inhibition of distracting stimulus or irrelevant information in working memory, making strategies for encoding and retrieval, and direction for all kinds of problem solving, decision making, and other goal oriented activities.

Pre frontal cortex with its extensions till posterior cortical regions has their influence in executive functions. Cognitive aging is ascribed to executive control deficits, which has been described as frontal lobe hypothesis of aging. In support of this hypothesis, studies of both structural and functional neuroimaging have revealed a greater decline in older adults with respect to volume and function of prefrontal brain regions. Studies employing behavioral paradigm are relatively lesser. Though it can stated that cognitive decline occurs with age, the manifestation may be different for different cognitive skills not many studies have been carried out in the past especially for the attention domain and moreover the studies have been carried out in western context and the results cannot be generalized readily to Indian context

Need for the study

Cognitive changes across age and across domains is individual specific. Everyday activities and its quality are defined with these cognitive changes with change in age. Trend of change in cognitive abilities from younger to older adults is an interesting fact to be observed. Hence need of the study is derived to note change in one of the cognitive process that is attention in younger and older adults.

Attention being one of the major component in cognition for speech and language processing, need to asses such process in linguistic paradigm was set. Therefore the current study was planned to tap attention using linguistic paradigm. The aim of the study was to measure selective and divided attention span in younger and older adults with respect to mean reaction time and accuracy score. Thus the present study was planned with the following objectives:

- To study selective and divided attention in younger and older adults.
- To compare the two different types of attention and track its pattern in aging.

Chapter II

Review of literature

2.1 Cognition

Definition:

Cognition indeed refers to "the mental process by which external or internal input is transformed, reduced, elaborated, stored, recovered, and used. As such, it involves a variety of functions such as perception, attention, memory coding, retention, and recall, decision making, and reasoning, problem-solving, imaging, planning and executing actions. Such mental processes involve the generation and use of internal representations to varying degrees, and may operate independently (or not) at different stages of processing". (Neisser, 1967).

Our day to day life involves several activities which includes cognitive processes such as attention, memory, problem solving and decision making. In order to understand the information present in our surrounding, we need to be alert and conscious, this is named as attention and it is one of the major cognitive processes that are pivotal in daily life.

2.2 Attention

Attention is a domain of cognition which is constantly explored. Attention is defined as a kind of mental task in which individuals narrow down their choices to select certain kinds of perceptual stimulus for further processing, while excluding other interfering stimuli. Alertness in physical and mental status of an individual is denoted as attention. Attention

has an important role in information processing. James (1950) defines attention as out of all sensations yielded, picks out certain ones worthy of its notice and suppress all the rest.

Major function of attention is to select particular information for processing. Many authors in their research prove decline in information processing with increase in age, along with deficits in sustained attention, divided attention and selective attention. Sustained attention decay is noticed in elderly population as per study conducted by Parasuraman in 1989. A study was carried out by Tun and Wingfield, in 1995, were a divided attention questionnaire was used and older adults rated themselves low in carrying out activities with combinations. We can make a strong stand on decline in attention span in older adults based on previous studies.

2.3 Types of attention

Different range of attention are present that are used in different situation and that are sensitive to different variables. Attention is often classified into three categories namely selective attention, divided attention and sustained attention. According to Kellorg (2007) selective attention is the ability of an individual to focus on particular stimulus irrespective of other stimulus present. It is often observed that have the ability to pay minimal attention to irrelevant stimulus. Selective attention has been measured using dichotic tests and stroop tests (Lemos & Daniel, 2013; Stormark, Laberg, Nordby & Hugdahl. 2000). With knowledge of distractor and target information and experience in the same can alter the age related difference in selective attention. One such evidence comes from a study carried out by Clancy and Hoyer (1994). Middle aged medical technicians within age range of 40 to 68 years were considered and visual search task was

carried out to read X-ray films. In these familiar tasks the middle aged participants performed unlike younger participants. Interestingly, in another task which was unfamiliar to the participants that included letter search was carried out. This experiment had worse results for middle aged participants than younger participants.

Another factor that can affect selective attention is how familiar is the distractors. Wright and Elias, (1979) demonstrated such effects on selective attention. This study revealed younger and older participants performed in a similar way because target information was more familiar than the distractors. This concludes that most irrelevant distractors are easily neglected than relevant distractors to the target. Madden's (1982) study also support the same. Discrimination of unknown targets from distractors is a tough task and older adults are likely to show deficits in such performances in comparison with younger adults. With experience or by cues the deficits may reduce.

Sustained attention refers to ones ability to actively process incoming information over a period of time. Filley, 2001, describes sustained attention as a selective attentionto the stimuli for a more extended time period. Sustained attention is most often measured by vigilance tasks. Giambra (1993) reports to have a mixed evidence regarding sustained attention change over life span. More subtle distinction between targets and non targets tend to have larger age related differences. Gaimbra in 1993, lists out few contributors that often can be attributed to change across age in sustained attention. They include stimulus discriminability, stimulus duration and working memory load. Thus age difference alone does not appear to be due to sustained attention, other aspects of tasks also play a role.

Ability of an individual to respond to multiple tasks simulataneosly is reffered to divided attention. This type of attention is considered as higher form of attention. Research has suggested that, the\re will be a decline in performance of atleast one task while carrying out multiple tasks.

Dunn (1993) carried out study, where in the he states that, there is an effect of practice on divided attention tasks. Study by Hirst ,Spelk, Reaves, Caharack, and Neisser in 1980 support the same. Sustained attention is paying attention for a span of time on a particular stimulus.

In aging research, simulatneous presentation dual task studies have consistently shown larger dual task studies have consistently shown larger dual task cost for older than for younger adults. These results have been interpreted as evidence that older adults have decrements in attentional capacity.

2.4 Attention and Langauge

Listners comprehend speech based on various factors. The linguistic formulations of the speech plays a major role in better perception and comprehension of speech. The entities like emotions, inner meaning, expression, context and so on. But all these do not go hand in hand and listner might miss out these information which will hamper communication. One of the cognitive process that is required to enhance communication in such conditions is attention process. Attention plays a major role in langauge comprehension and improves communication. Attention also plays a role in selection of information to the context, sustained attention in order to attentiod to speech for longer period of time, where as divided attention in dichotic listening conditions. One such study was carried

out by Stuss, Shallice, Alexander and Picton (1995), wherein they attempted to divide attention by identifying five main component processes underlying the performance of attention tasks with respect language: monitoring, energizing, inhibiting, contention scheduling adjustment, and if-then logic control. They saw these five as occurring in various combinations, as needed, in a variety of types of attention demanding situations, including sustaining attention in slow-changing situations in which vigilance is required, concentrating attention during fast paced, highly demanding activities, sharing attention when different cognitive activities must be executed at the same time, suppressing attention when inappropriate action schemata are automatically activated, and shifting attention focus when a complex activity frequently presents changing demands. All of these types of attention-demanding situations (among others) are encountered in the skilled use of language. When applied to language, they have something in common: They all focus on the way "attention enhances processing of the stimuli that are being attended, and inhibits the processing of representations that have been activated but are not relevant to the task that the individual is performing" (Eviatar, 1998, p. 283; Fischler, 1998).Language itself can be viewed as an attention-directing system, in a sense expressed by many cognitive linguists (Langacker, 1987; Talmy, 1996, 2000; Tomasello, 1998). Language serves to direct the communication partners 'attention as individual builds a mental representation of the meaning conveyed in the incoming message. Particular elements of the message especially function words and other grammatical devices like phonology, syntax and morphemes, requires receiver's attention which is crucial in better communication. Studies by Posner (2004); Darcy, Mora de and Daidone (2014); Maidhof and Koelsch (2011) explains the role of attention in processing syntax,

phonology, discourse comprehension and other grammatical representations of language. Attentional flexibility is generally thought to play an important role in L2 learning, hence majority of studies focus on attention over second language. Language learning and attention process is most often explained in second langauge acquisition as well. Segalowitz and Frenkiel-Fishman in 2005 investigated attention control and second language proficiency in English-French bilinguals, where in attention control with second language proficiency was rated as 59% of attention control with higher proficiency in second language followed by 32% attention control in lesser proficiency. Darcy, Mora de and Danielle (2014) investigated attention Control and inhibition Influence phonological Development in a Second Language in English- Spanish bilinguals. They suggested that a more efficient attention control and inhibitory skill enhance the processing of phonologically relevant acoustic information in the L2 input and may lead to more accurate L2 speech perception and production.

All these evidences helped to derive a need in measuring attention process with linguistic stimuli and in second langue which adds on the complexity to render attention per se in the tasks that are used. Hence this study focuses on measuring such attentional process including selective and divided attention in a linguistic paradigm using second language.

2.5 Neural co-relates for Attention

Brain undergoes remarkable structural changes across age and also atrophy rate differs across and within areas of brain. With respect to gray matter volumetric measurements, studies have shown that steepest rate of decline seen in frontal lobe followed by parietal, later followed by temporal lobe with very minimal loss in occipital lobe. White matter

volume measurements and its integrity also showed differential aging effects throughout the brain. This co-relates with aging in the domain of visual perception, attention, and language, working memory, implicit memory, episodic memory, encoding and retrieval.

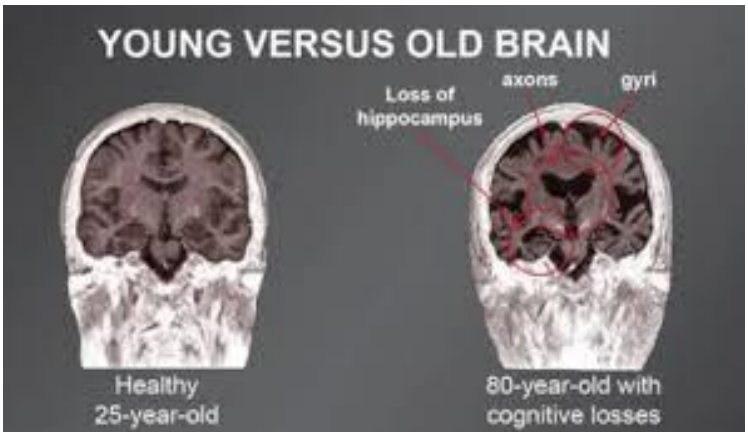


Figure 1: Neuro-imaging in younger and older adults.

Studies revealed two consistent patterns of age related changes in addition to many task specific differences. The different pattern observed in brain activity is a posterior anterior shift in activity in older adults and a general reduction in asymmetry of brain activity. The increase in activation in prefrontal regions is attributed to a compensatory mechanism for age related deficits in other brain regions. This increased recruitment of higher order cognitive processes may be indicative of alternate strategies employed by older adults when presented with cognitive demand tasks and subtle rearrangement of neural networks.

Functional neuroimaging studies have observed altered patterns of activity within prefrontal cortex during working memory, encoding, and attention tasks across age, often showing less activity in older than younger adults (Cabeza et al., 2000). Various studies have explained role of parietal cortex in attentional control, often focusing on its

involvement in visual selection, orienting of attention, shifting of attention, and stimulus-to-response mappings (e.g., Corbetta, 1993; Coull & Nobre, 1998; Corbetta, 1998; Wojciulik & Kanwisher, 1999; Banich 2000b; review by Cabeza & Nyberg, 2000).

Other studies also describe parietal and prefrontal activity co-occurrence in attention activities. (Cabeza & Nyberg, 2000).Structural and functional connectivity between prefrontal and parietal cortex is also been explained by other several researchers (Cavada & Goldman-Rakic, 1989; Neal, 1990; Morecraft, 1993; Cabeza et al., 1997), which suggest interdependence of these regions in attentional tasks. As such, age-related changes in parietal function may also decrease the brain's ability to implement attentional control.

Compromise of attentional control in older adults can be seen if structures related to attentional control is unaffected (e.g., prefrontal cortex, parietal cortex, and anterior cingulate cortex), but functional connections and interactions between these may decrease. Age-related changes in the functional connectivity of prefrontal cortex with other regions of the brain have been noted. Study by Cabeza et al (1997) supports the same, where the author found reduction in functional connectivity between prefrontal cortex and parietal cortex. Decreases in the extent of activation in occipital cortex, noted by other neuroimaging studies of aging. According to Grady et al., 1994 and Madden et al., 1997 there was a trade-off between activity in occipital cortex and temporal or parietal cortex. Such trade-offs may reflect the presence of compensatory mechanisms.

Dickstein, Castellanos, and Milham in 2006 studied neural correlates in attention deficit hyperactivity disordered individuals with ALE meta-analysis method using fMRI. There results , showed significant patterns of frontal hypo activity in patients with ADHD, affecting anterior cingulate, dorsolateral prefrontal, and inferior prefrontal cortices, as well as related regions including basal ganglia, thalamus, and portions of parietal cortex.

2.6 Models of attention

Models of attention are explained through two classes of theories. They are Bottleneck theory and Capacity theory. Based on these principles models are divided as follows.

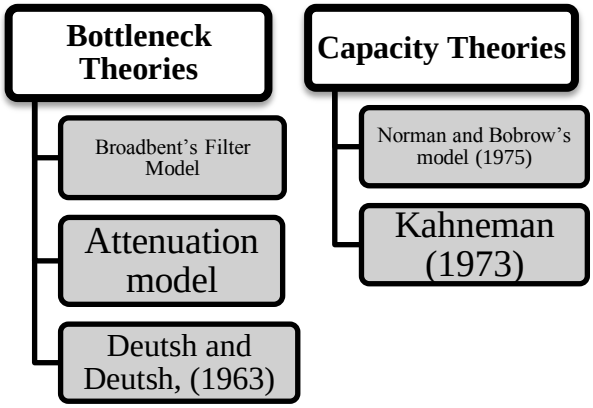


Figure 2: Models of attention

Bottle neck principle explains the restriction in flow from one to another. Bottleneck theories propose that there is a similar narrow passage way in human information processing. This limits the quantity of information to which we can pay attention. It regulates the flow of information and prevents overload of information. They are also named as theories of *selective attention* because they describe how some information is selected for processing as the rest gets discarded.

Examples:

- Broadbent's filter model
- Treisman's attenuation model
- The Deutsch – Norman memory selection model
- The Multimode model

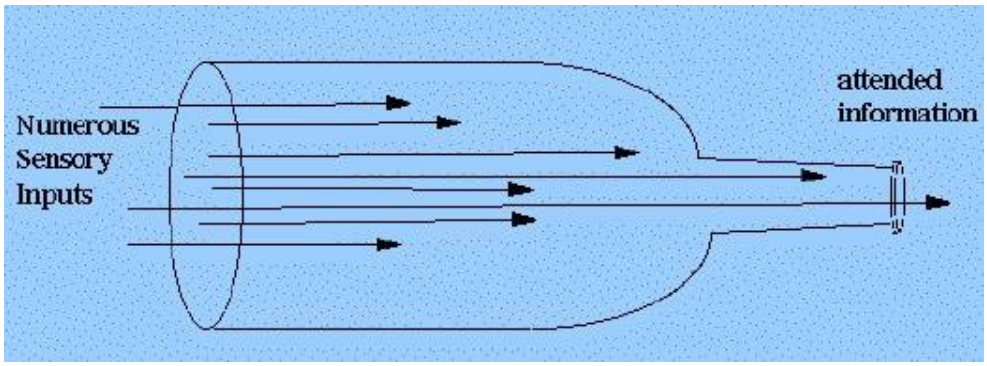


Figure 3: Depiction of Bottle neck principle

Capacity theories: These are essentially *theories of divided attention*. They conceptualize attention as a limited resource that must be spread around different informational sources.

Examples:

- Kahneman's capacity model
- Norman &Bobrow's model

As described by Models of attention, Hasher and Zacks (1988), models of attention accept that attentional control is responsible for inhibitory functions. Distributed network of structures within the brain, including anterior cingulate cortex, prefrontal cortex, parietal cortex, extra striate cortex, superior colliculus, thalamus, and the basal ganglia, supports attention function. Co-ordination of activities within these networks is responsible for selection under situations that demand attention and to carry out complex goal oriented behaviors which is referred as attention control. Activation of relevant information and suppression of irrelevant information within these processing systems is explained under these models.

Recent models of attention control (e.g., Banich et al in 2000a & 2000b; MacDonald et al., 2000) suggest that dorsolateral prefrontal cortex (BA 9 and BA 46) maintains an attention set through modulation of the activity within posterior processing systems and facilitating the selection of task-relevant representations within working memory.

2.7 Factors affecting attention

Various factors affect performance of older individuals in attention tasks include familiarity of tasks, placement of distractors during presentation, experience, exposure time for the stimulus, discriminability stimulus, working memory load and so on. There are studies supporting these factors. Study by Giambra in 1993 lists reasons for deviation in performance of older adults than younger adults other than aging factors. He contributes to (1) distractibility of stimulus, (2) duration of stimulus and (3) working memory load. With respect to presentation of stimulus a study by Wright and Ellis in 1979, had presented distractors always at the center of the screen and hence he attributes

this to be easy in neglecting irrelevant information and lead to better performance in older adults. Study by Clancy and Hoger in 1994 supports that age related differences in selective attention may be reduced if the older individuals have experience with target and distractor information.

Other factors that change the efficiency with which older adults process information includes, medications which induce effects like drowsiness and mental dullness; sensory changes which can intervene the efficiency in processing of information (e.g., loss of hearing which can affect whether or not someone's name is heard when introduced); health related changes which can affect as concentration and processing speed; and also changes in mood such as depression and anxiety which can alter one's motivation to learn new information and to apply active strategies.

2.8 Attention pattern across age groups using various methods

Attention being one of the major components that face decline in older adults are studied under many conditions and through various methods, including behavioral, imaging and other types of studies. Here we discuss few behavioral studies with that asses attentional control in both younger and older adults. Lemos and Daniel (2013) investigated the associations between selective attention and cognitive decline in institutionalized elderly through stroop variables. 140 elders with age range of 60-90 years were recruited to the study and results shows a cognitive decline in 52% of the population recruited and selective attention is one of the symptom of decline. A study on Number-Stroop performance in normal aging and Alzheimer's-type dementia by Girelli in 2001 reveals selective attention breakdown in normal older adults and Alzheimer's type of dementia.

Attention function with gender variability and with aging was studied Commodari and Guarnera in 2013, they considered 80 participants (44 men, 36 women) with mean age of 55–65 years. The participants were further divided into two groups; group 1 comprised of participants between 55–59 years while group II comprised participants between 60–65 years of age. Multitask computerized assessment was used to tap attention in these individuals. The test involved seven tasks assessing simple reaction times and choice reaction times, visual, visual-spatial and auditory selectivity, digit span, divided attention, resistance to distraction, and attentive shifting. Where in significant differences related to genders were found in attention shifting. To test possible decline in attentive function with age, performances among two age groups (55–59 and 60–65 yrs) were compared. Significant differences were shown in simple immediate attention span, selectivity, capacity to inhibit interference of non-pertinent signals, and attentive shifting.

Imaging studies also lay its own role in study of attention; few of them are discussed below. In fMRI Study of the Stroop Task by Milham et al in 2002 included two groups of right-handed, native English-speakers recruited from the Champaign– with 10 participants from with age range of 60 to 75 years and 12 participants with in age range of 21 to 27 years on whom, stroop task was administered. In which increased attention control activating a network of structures, with increase in age. Age-related differences were noted within regions thought to be involved in the implementation of attention control, especially prefrontal and parietal cortices.

Most of the studies used to asses attention capacity in this population include non-linguistic tasks. Hence need arises to asses attention capacity in normal older adults with linguistic stimuli. Current study aims at measuring the selective and divided attention

span in younger and older adults using linguistic paradigm. This study focuses on two types of attention; selective and divided attention span and comparison across the groups will be carried out.

2.9 Attention in clinical population

As discussed above cognitive impairment is a natural part of the aging process. When these deficits do not impair their ability to function in daily life then impairments can be typically accompanying healthy or successful aging. When such impairments hinder there daily life participation then it can be due to pathological aging. Cognitive decline in such population is discussed below.

Alzheimer's Disease (AD) is the most common cause, accounting for an estimated two-thirds of all cases of dementia. Clinical profiling of AD includes memory impairment in addition to decline in one other area of cognition including language, motor function, attention, executive function, personality, or object recognition. Episodic memory is one of the notable deficits for patients with mild AD. In milder cases semantic memory is relatively spared and as disease progress significant semantic deficits are noticed. They are explained by word finding difficulty. Alzheimer's patients also show deficits in the working memory. Deficits particularly more on tasks requiring dual-task performance, which leads to an inference that primary deficit in AD may be in "executive functions," the ability to flexibly shift attention and to attend to goal-relevant information.

Like other clinical populations Parkinson's also exhibit relative impairment in executive functions, resulting in a phenotype resembling that of frontal lobe patients (Robbins and

Arnsten 2009), with deficits in attention (Ballard et al. 2002), planning, concept formation, and working memory (Kehagi et al. 2010).

Memory deterioration in Parkinson's affects both spatial (Levin 1990) and non-spatial working memory domains (Matison et al. 1982), implicit memory (Heindel et al. 1989; van Asselen et al. 2009), episodic memory, and procedural learning (Dujardin et al. 2003) in particular, whereas the ability to form new episodic memories is preserved (Knowlton et al. 1996; Squire and Zola 1996; Dubois and Pillon 1997). The earliest symptoms in Parkinson's which are frequently reported are deficits in visual perception (Levin 1990; Lee et al. 1998) and object recognition (Laatu et al. 2004) with an apparent independency from the severity of motor dysfunctions, neuropsychiatric complications, and general cognitive deterioration (Girotti et al. 1988; Antal et al. 1998). Primarily aphasia is characterized by impairments in the comprehension and/or expression of language, research has shown that patients with aphasia also show deficits in cognitive-linguistic domains such as attention, executive function, concept knowledge and memory (Helm-Estabrooks, 2002).

Cognitive deficits in aphasia have been described as decreases in executive function, which are high-level controlled processes to activate, organize, self-monitor and regulate flexible responses to various goal-directed activities, based on internal and external feedback (Lezak, 1995; Philips, 1997). Dual task paradigms have been used to explore the relationship between limited attention and language comprehension. La Pointe and Erickson (1991) conducted a study to explore sustained auditory attention in individuals

with aphasia. Individuals with aphasia performed similarly to the control participants on the vigilance only task but more poorly on the auditory sustained attention. It is a crucial component of auditory comprehension because maintaining sustained attention to monitor auditory input is fundamental to understanding a message.

Right Hemisphere plays a particular role in orienting attention, unlike left hemisphere, the right hemisphere attention across spatial boundaries and plays a role in maintenance of attention in vigilance. Arousal system is lateralized towards right hemisphere. Right hemisphere damage leads to cognitive-communication problems, such as impaired memory, attention problems and poor reasoning. According to Myers (1994), Impairments of perception and attention are the underlying causes of the extra-linguistic, linguistic and nonlinguistic deficits manifested in patients with RHD. Love and Webb (2001) stated that neglect, inattention and denial are three major characteristics of right hemisphere syndrome.

Attention as such is not just measured in clinical population but also in normal older individuals. There are no normative as such to derive a conclusion at differentiating between senile and senescence. Present study helps to understand about the selective and divided attention span in younger and older adults and verify if the concept of cognitive decline in older adults is applicable to the domain of cognition also.

Chapter III

Method

3.1 Aim of the study: The aim of the study is to measure selective and divided attention span across two age groups which include younger and older adults.

3.2 Objective:

3.2.1 To study selective and divided attention in younger and older adults.

3.2.2 To compare the two different types of attention and track its pattern in aging.

3.3 Design: Standard group comparison

3.4 Participants

Total of 60 participants were taken to the study. Participants were divided in to two groups as Group I and Group II. Group I comprised of 30 neurologically healthy young adults within age range of 18 to 25 years and Group II comprised of 30 neurologically healthy older adults, age range 55-65 years recruited from the city of Mysore.

Participants with minimal education level of SSLC and Kannada-English Bilinguals with proficiency level of second language within the range 3 or 3+ for the reading domain according to ISLPR (Ingram, 2000) were included in the study. Participants with any neurological insult and sensory impairments were excluded. The details of participants of Group I and Group II are included in the tables mentioned below.

Table 1: *Details of Group I participants*

No.	Age/gender	Education
1	22/M	B E
2	22/M	B E
3	23/M	MBA
4	23/M	M tch
5	23/M	B E
6	22/M	Diploma
7	22/F	Msc
8	22/F	Mscslp
9	25/F	Mscslp
10	23/F	B E
11	23/F	B E
12	23/F	Mscslp
13	23/F	Msc SLP
14	23/F	Msc Audio
15	22/M	Msc SLP
16	23/F	Msc SLP
17	22/F	Msc audio
18	24/F	Msc SLP
19	24/M	Msc SLP
20	22/M	B E
21	24/F	Msc SLP
22	23/M	B E
23	19/F	BscSpn Hg
24	19/M	BscSp n Hg
25	21/M	B E
26	18/M	PU
27	21/M	Intern
28	20/M	PU
29	25/M	B E
30	20/F	BscSp n Hg

Table 2: *Details of Group II participants*

No.	Age/Gender	Education
1	57/F	Degree
2	61/M	Degree
3	62/M	Degree
4	60/M	Degree
5	60/M	SSLC
6	62/F	Degree
7	60/M	Degree
8	62/M	Degree
9	60/M	Degree
10	64/F	Degree
11	57/M	Degree
12	55/F	Degree
13	55/F	Degree
14	57/M	Degree
15	60/M	Degree
16	56/M	Degree
17	55/M	SSLC
18	58/M	Degree
19	58/F	Degree
20	55/F	Degree
21	57/F	Degree
22	60/F	Degree
23	60/F	Degree
24	60/M	Degree
25	58/M	Degree
26	65/F	Degree
27	55/F	Degree
28	65/F	Degree
29	63/F	Degree
30	59/M	SSLC

3.5 Material and Tasks

The aim of the present study was to asses selective and divided attention. Selective attention was assessed by employing two tasks. First task was Navon's letter identification task, wherein two sets of letters one being congruent (letter shape and its constituents are same) and other being incongruent (letter shape and its constituents are unlike) was presented visually on monitor screen and second task was letter monitoring task with preset letter 'P', where in a set of word list with preset letters and neutral words without preset letter were presented randomly through auditory mode. While divided attention was also assessed under two conditions. First being letter monitoring with two preset letters 'B' and 'T', where in set of word list with preset letters and neutral words without preset letters were presented randomly through auditory mode and second task is audio visual synchronization task. In which ANT pictures were presented on monitor screen along with which recorded phrases presented through auditory mode.

The mode of presentation of presentation was visual for first task of selective attention and auditory for second task of selective attention and first task of divided attention. While the stimuli for second task of divided attention presented in both visual and auditory mode.

3.6 Stimulus or materials used

Stimulus varied across the tasks. For Navon's letter identification task, both congruent and incongruent letters were developed. Whereas for letter monitoring tasks with one and two preset letters, a word list of 30 with preset letter 'P' and a word list of 40 with preset letters 'B' and 'T' respectively were used. The second task of divided attention had picture stimulus from ANT test which were randomly chosen and 40 recorded phrases which were both congruent and incongruent with the pictures.

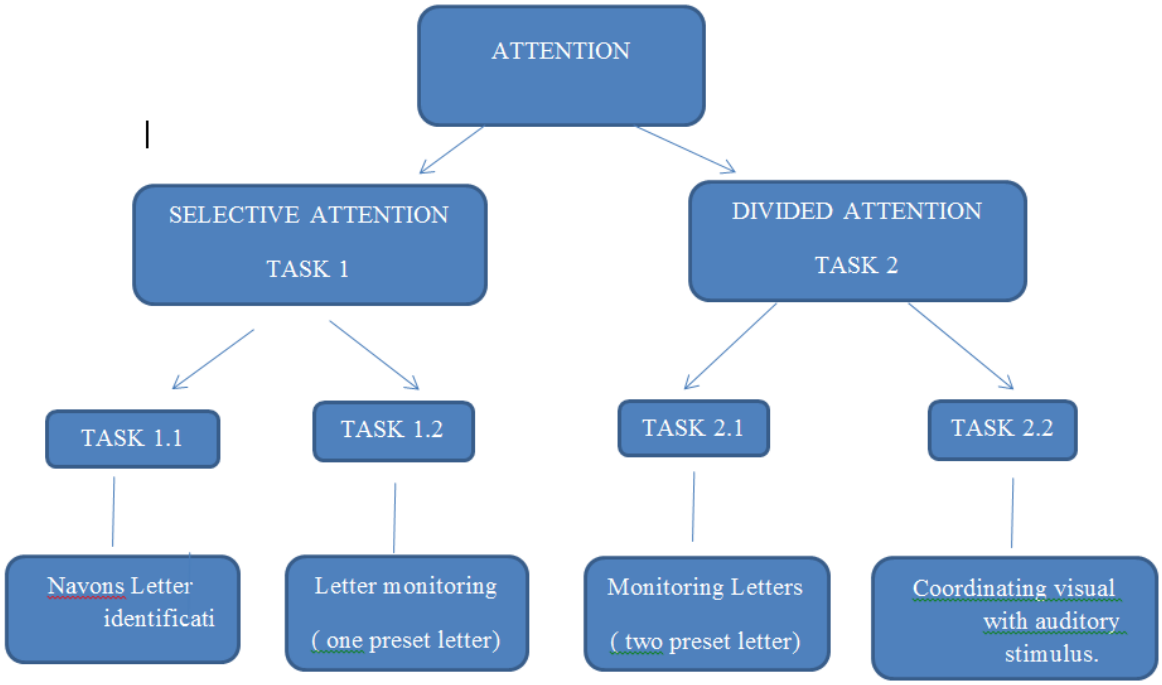


Figure 4: Summary of tasks

3.7 Instrumentation

Stimuli were presented using 15.6 VIAO Sony laptop and Creative HS 320, headphones with the help of DMDX software version5.0. Auditory stimuli were recorded using Adobe audition software version 2.1.1.

3.8 Testing environment

Participants were seated with 50cm distance from the monitor screen. The stimuli used to tap selective attention and divided attention was in English, the L2 of the participants in order to counteract the effect of language proficiency. As native speakers are expected to identify the letters in his or her language easily the load on the participants would be less hence stimuli were L2.

3.9 Procedure:

Selective and divided attention was assessed using two tasks; Task 1 and Task.

3.9.1 Selective attention was assessed under two conditions:

In the first task, ***Navon's letter*** was presented visually on a 15.6 inch laptop screen. Participants were instructed to press '1'for the congruency condition, if the letter shape matches with its elements and press '0'for the incongruent condition, if the letter shapes did not match with its elements. The font sizes of Navon's figures were adjusted in such a way that it occupies the center of the screen.

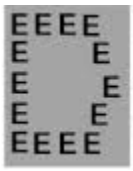
a)  b) 

*Figure 5:*Examples for Navon's letter (a) Congruent D, (b)Incongruent D

Example: In figure 1 (a) the expected response was to press key 1 as letter D is made up of D itself and they match. In figure 1(b), letter D has E as its elements. The expected response was to press key '0'.

3.9.2 Letter recognition task was the next task used to tap selective attention .In this task a preset letter 'P' was given to participants. A set of '30' number of words were presented through auditory mode. The list of words included words (nouns and verbs) with letter 'P' and without letter 'P' and was presented randomly through headphones.

Participants were instructed to respond through functional keys by pressing the key '1' if the letter 'P' is present in the word irrespective of the position of the letter and press the key '0' if the letter 'P' is absent in the word presented.

For example: Words like pen, cot and so on were presented. Participants were expected to respond by pressing key'1' when "pen" is presented and '0' when cot is presented as /p/ is presented in pen and not in cot.

3.9.3 Divided attention was assessed through two conditions:

First condition was recognition ***of letters task***. Here two preset letters 'B' and 'T' were given to the participants. Set of 40 number of words were presented randomly which included words with letter 'B' alone, words with letter 'T' alone and neutral words which did not contain either of the letters. Mode of presentation of stimulus will be in auditory mode. Words did not contain both the target letters. Participants were instructed to respond after each stimulus with response key '1', if the first target letter is present in the word, irrespective of the position and key '0', if the second target is present in the word presented. Catch trials were added randomly in between the word list which contained neutral stimulus in order to rule out false positive response. The participants were expected to press '0' for catch trails.

3.9.4 Second condition is where ANT picture stimuli were presented randomly through visual mode, on a 15.6 inch laptop screen with one second interval between two pictures; simultaneously phrases recorded were presented through auditory mode using headphones. Participant's task was to pay attention to both the stimulus at a time and respond through response key '1', if the picture presented matched with the phrase presented through auditory mode and with key '0' if the stimuli do not match.

3.10Analysis

In analysis, we have tried to distinguish the performance between group I and group II individuals with respect to mean reaction time and accuracy score. In order to accomplish this the following combination of analysis was taken; (1) mean reaction time across group I and group II in two tasks of selective attention and divided attention, (2) accuracy score across group I and group II in selective and divided attention span.

Chapter IV

Results and Discussions

The aim of the present study was to investigate selective and divided attention span in younger and older adults. Total of 60 neurologically healthy individuals were recruited for the study and they were further divided into two groups designated as group I and group II. Group I comprised of 30 younger adults in the age range of 18-15 years. While group II consisted of 30 older adults in the age range of 55 to 65 years. Equal numbers of male and female participants (15 each) were considered under each group. These individuals were bilinguals with English as their second language and minimum education level of these participants was SSLC.

The objectives of the study are as follows:

a. To study selective and divided attention in younger and older adults.

b. To compare the two different types of attention and track its pattern in aging.

Selective and divided attention was assessed through two tasks each. In order to verify if the distribution was normal, Shapiro Wilk's test for normality was used. It was observed that p value was lesser than the cut off of 0.05 for both selective attention tasks and divided attention tasks expressed in terms of mean reaction time and accuracy scores indicating that the distribution is abnormal. Results of the same with respect to objectives of the study are explained in the below sections.

a) **Comparison of selective and divided attention between younger and older adult participants (across age groups).**

The performance on the two tasks of selective attention and divided attention was determined by the mean reaction time and accuracy of scores. The overall mean, standard deviation (SD) and median scores of Group I (younger adults) and Group II (older adults) for the two tasks of selective attention in terms of reaction time was computed and shown in table 3.

Table 3: *Performance of Group I and Group II individuals on Selective attention tasks in mean reaction time(ms)*.

	Group I			Group II		
	Mean	**Standard deviation**	**Median**	**Mean**	**Standard deviation**	**Median**
		Task 1			**Task 1**	
Male	972.63	316.06	1071.00	1661.69	311.19	1689.99
Female	1098.38	255.35	1102.50	1710.74	484.31	1863.25
		Task 2			**Task 2**	
Male	496.46	121.36	483.73	619.11	313.61	509.76
Female	545.97	141.53	523.87	627.39	236.84	563.44

Mean, SD and Median for Group I (n=30) and Group II (n=30) across two task.

The above table describes mean reaction time for both group I and group II on the tasks of selective attention across gender. Group I individuals had lesser mean reaction time compared to group II individuals on tasks of selective attention. Mean values and median values followed the same pattern in both the groups. It was seen that males had lesser reaction time compared to females in both the groups for tasks of selective attention.

Out of the two tasks of selective attention (SA 1 v/s SA 2); mean reaction time was more for task 1 compared to task 2. Standard deviation was observed to be higher in group II individuals compared to group I individuals for both the tasks of selective attention. Among the two tasks, first task of selective attention had greater standard deviation compared to the second task.

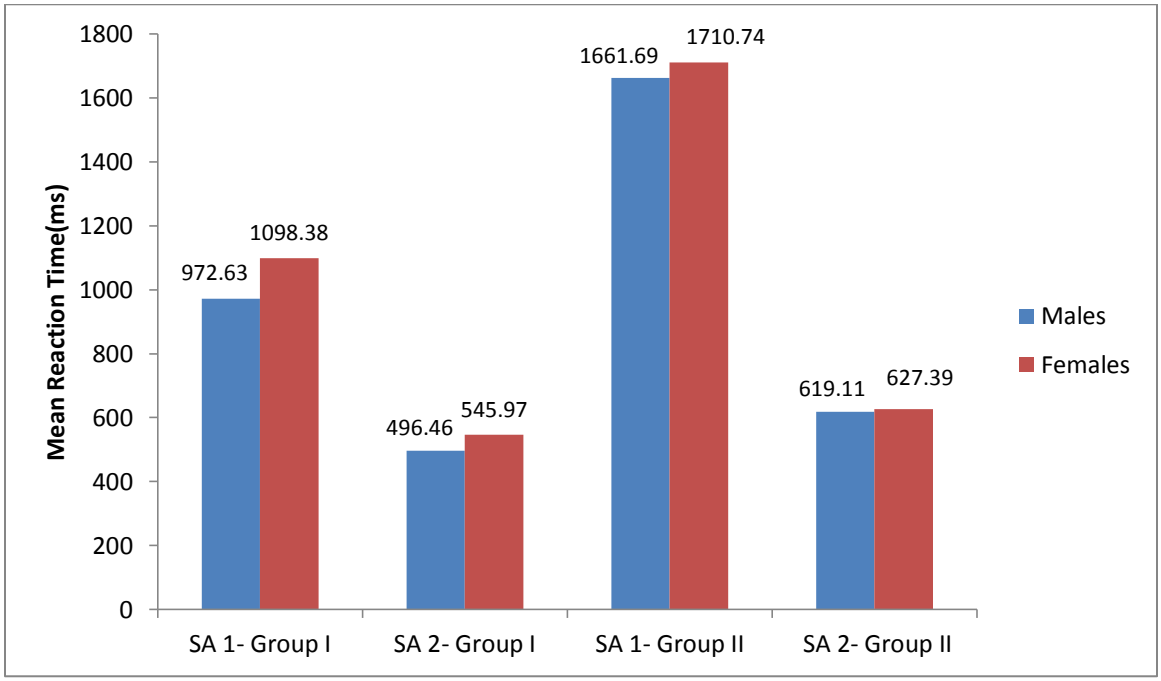


Figure 6: *Comparison of mean reaction time (ms) for group I and group II on selective attention task 1(SA1) and task 2(SA2).*

Comparison of performance of group I and group II individuals was further carried out by using Mann-Whitney U test. The |Z| value obtained for task 1 and task 2 was 5.293 ($p<0.05$) and 0.976 ($p>0.05$) task II respectively. The performance (measured in mean reaction time) was statistically significant for the two groups on task 1; while for task 2 of selective attention there was no statistically significant difference between the two groups. The present objective also included comparison of accuracy score in group I and group II individuals. Table 4 gives a description of mean, standard deviation and median values of accuracy score in the tasks of selective attention.

Table 4: *Performance of group I and group II individuals on selective attention tasks with respect to accuracy score (%).*

	Group I			**Group II**		
Gender	**Mean**	**Standard deviation**	**Median**	**Mean**	**Standard deviation**	**Median**
		Task 1			**Task 1**	
Male	86.00	14.90	90.00	65.44	23.98	70.00
Female	91.66	6.98	95.00	70.66	20.25	80.00
		Task 2			**Task 2**	
Male	93.32	5.65	93.10	83.82	13.83	89.60
Female	95.05	3.12	96.00	93.30	6.04	93.10

Similar trend of performance in group I and group II individuals was noted for accuracy score , Group I participants performed more accurately compared to group II participants on both tasks of selective attention. Mean and median scores showed similar trend in both the groups on tasks of selective attention. Greater standard deviation was noticed in first task of selective attention for both the groups compared to second task of selective attention. Females were more accurate in their performance on both the tasks of selective attention compared to males, this was true for both group I and group II participants.

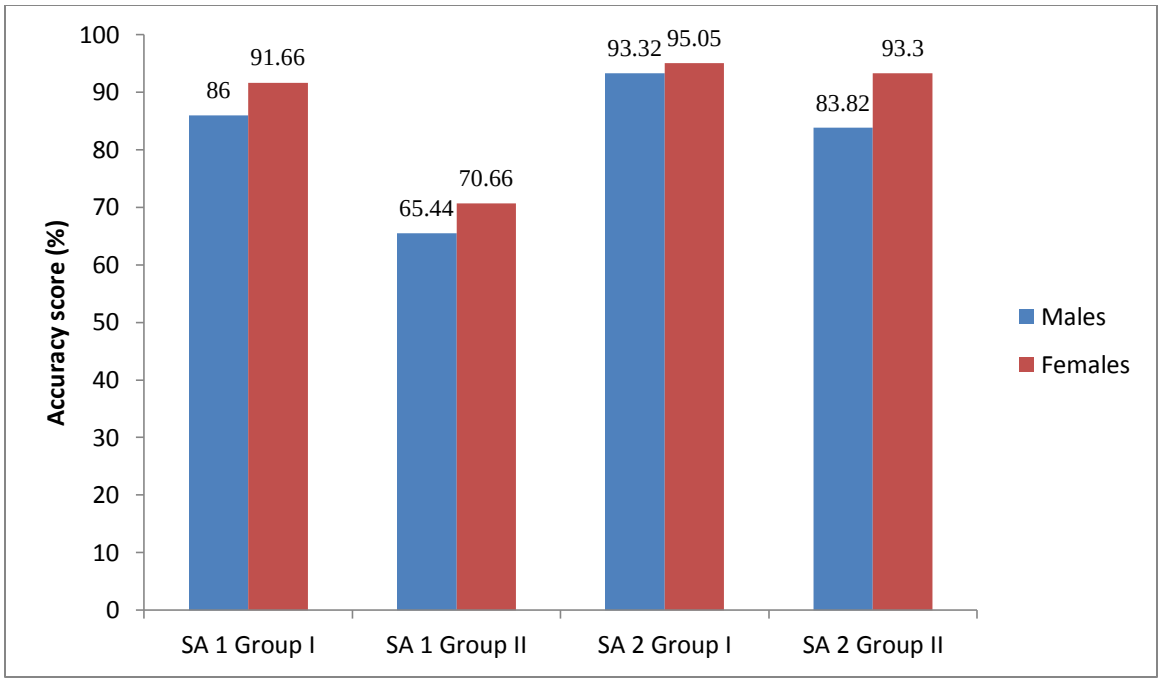


Figure 7: *Comparison of accuracy score (%) for group I and group II on task 1 of selective attention task 1 and task 2.*

Mann- Whitney U test was carried out for comparison across the two groups (group I and group II) on the two tasks of selective attention (SA 1 v/s SA 2). The |Z| scores for SA1 and SA2 were 4.527 ($p<0.05$) and 1.568 ($p>0.05$) respectively. Statistical significant difference was seen in task 1 of selective attention whereas for task 2 there was no statistically significant difference seen in Group I and Group II participants.

As part of first objective, comparison of two groups (younger and older adults) for the tasks of selective attention with respect to mean reaction time and accuracy score was carried out. Statistically significant difference was found in both the groups for tasks of selective attention. Older adults had greater mean reaction time and less accuracy score compared to younger adults. This can be attributed to difference in patterns of activity within prefrontal cortex during tasks of working memory, encoding, and attention across

age which shows less activity in older than younger adults (Cabeza et al., 2000) or age related changes with respect to speed of information processing (Salthouse 1996), poor inhibitory function or due to poor working memory capacity (Craik, Morris & Gick, 1990). According to researchers like Cavada and Goldman-Rakic, 1989; Neal et al., 1990; Morecraft et al., 1993; Cabeza et al., 1997 interdependence of frontal and parietal regions in tasks of attention and such age related changes in these regions affect attention control of older individuals. Usually the cognitive domains show a decline with respect to aging and attention is no exception. Tasks of selective attention require the attention focus on the stimuli with aging this ability would come down. Owing to which the performance on the tasks of selective attention would decline in aged individuals.

The performance of group I and group II individuals in terms of mean reaction time and accuracy score was compared for the two tasks of divided attention also. Table 5 represents mean, median and standard deviation for the two tasks of divided attention for group1 and group 2 in terms of mean reaction time (ms).

Table 5: *Performance of Group I and Group II individuals on Divided attention tasks with respect to mean reaction time (ms).*

	Group I			Group II		
Gender	**Mean**	**Standard deviation**	**Median**	**Mean**	**Standard deviation**	**Median**
		Task 1			**Task 1**	
Male	478.88	97.07	495.21	650.89	314.93	460.37
Female	491.70	128.51	430.47	613.63	253.92	582.94
		Task 2			**Task 2**	
Male	459.37	147.38	491.60	554.93	146.70	546.50
Female	470.62	149.32	450.80	533.44	145.41	517.25

As represented in the above table, mean reaction time (ms) for group I participants was less compared to group II participants. That is group II individuals consumed more time in completion of tasks compared to group I individuals. The mean reaction time (ms) was more in males compared to females in group I; whereas in group II, females had greater mean reaction time (ms) compared to males. Standard deviation in divided attention tasks for group II individuals was greater compared to group I individuals similar to the tasks of selective attention. Mean and median values proceeded in the same direction. Across the tasks of divided attention mean reaction time (ms) was less for task 2 (DA 2) compared to task 1 (DA1) in group I. Whereas in group II individuals, DA1 had greater mean reaction time compared to DA 2.

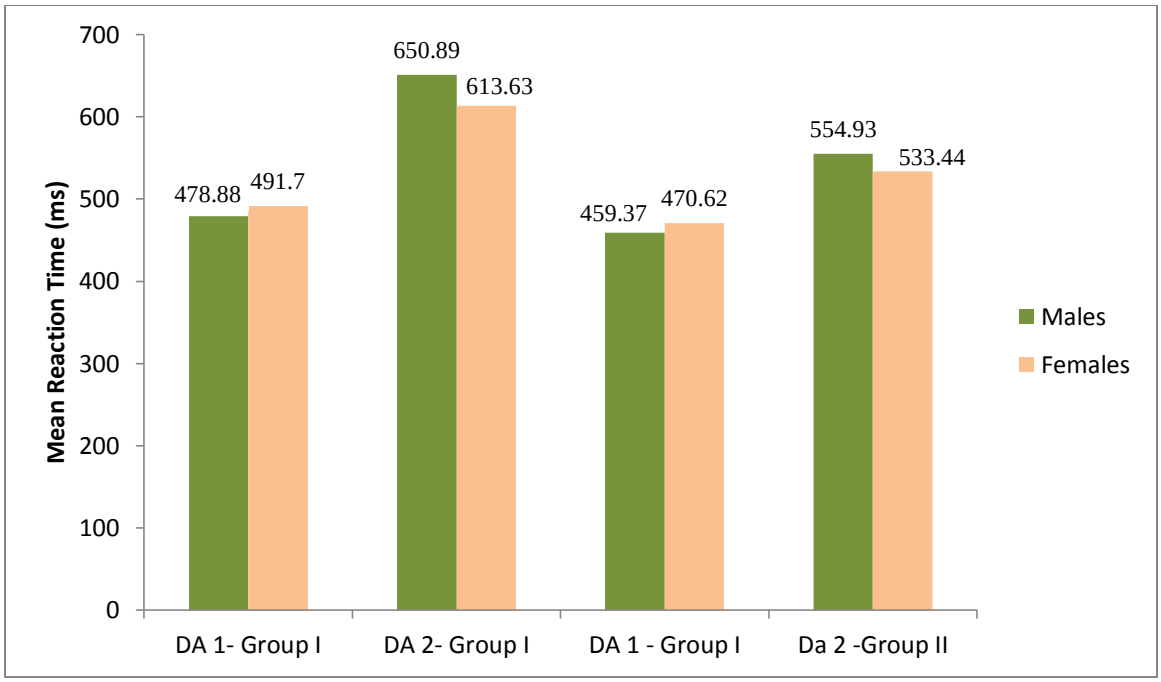


Figure 8: *Comparison of mean reaction time (ms) for group I and group II on task 1and task 2 of divided attention.*

Statistical analysis was further carried out using Mann-Whitney U test to compare the performance of the two groups. The |Z| score for DA1 and DA2 were 1.582 ($p > 0.05$) and 1.833 ($p > 0.05$) respectively. No statistically significant was difference noticed across the groups tasks of divided attention.

Accuracy score (%) was analyzed for group I and group II on both tasks of divided attention (DA1 and DA 2). The below mentioned table (table 6) represents the mean, standard deviation and median of accuracy score (%) in tasks of divided attention in both the groups (group I and group II).

Table 6: *Performance of group I and group II individuals on divided attention tasks with respect to accuracy score (%).*

	Group I			Group II		
Gender	**Mean**	**Standard Deviation**	**Median**	**Mean**	**Standard deviation**	**Median**
		Task 1			**Task 1**	
Male	85.33	8.54	87.50	86.26	12.19	90.00
Female	86.87	7.44	87.50	90.52	7.32	92.50
		Task 2			**Task 2**	
Male	95.16	3.59	95.00	87.50	5.00	87.50
Female	95.66	2.74	95.00	86.33	12.31	90.00

Group I individuals had better mean accuracy scores (%) compared to group II individuals. The findings were similar to the results obtained for the accuracy scores in selective attention. There was no major difference between the accuracy scores for males and females of group I in tasks of divided attention. However in group II participants, females had a greater accuracy score compared to males in both the tasks. Greater standard deviation was seen for group II individuals compared to group I individuals suggesting greater variation in group II. Mean and median values for accuracy scores suggested the same findings.

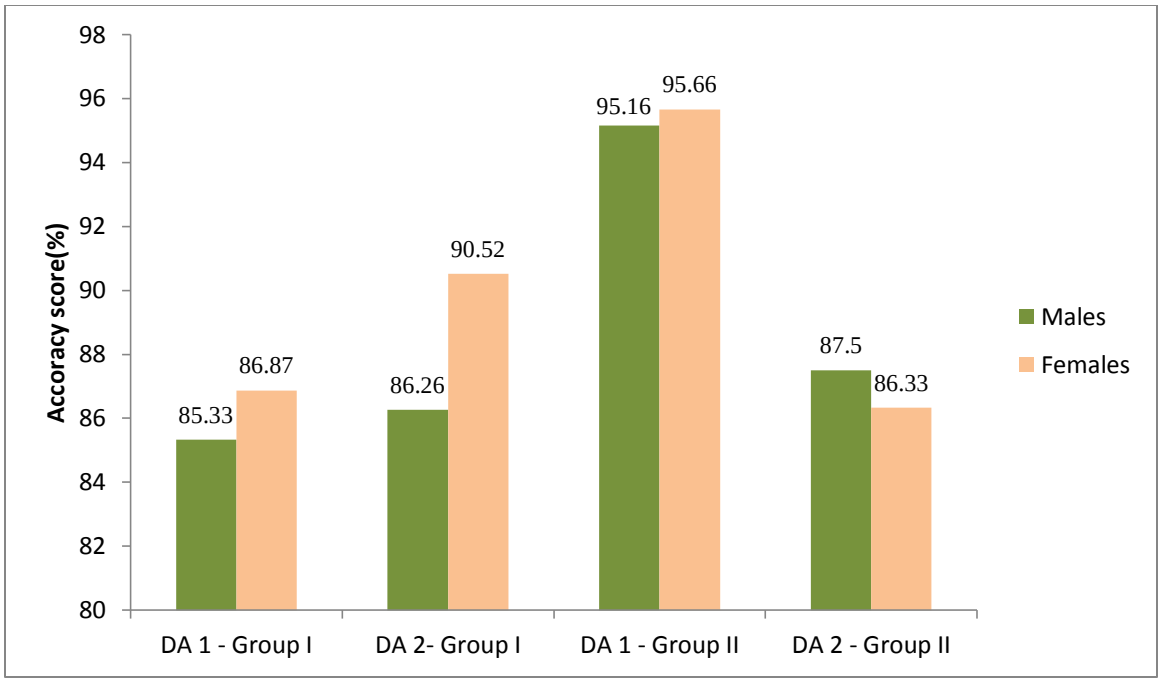


Figure 9: *Comparison of mean accuracy score(%) for group I (younger) and Group II(older) on task 1 of divided attention task 1(DA1) and task 2(DA2).*

The |Z| values for DA1 and DA2 were 4.78 ($p<0.05$) and 3.096 ($p<0.05$) respectively. Statistically significant difference was noticed in both the groups across the tasks. The performance of group I and group II individuals on the tasks of divided attention was measured in terms of mean reaction time (ms) and accuracy score (%). Group I individuals had lesser mean reaction time and greater accuracy score compared to group II individuals. However statistically significant difference was seen for only accuracy scores and not mean reaction time. Even though statistically significant difference was not found in mean reaction time on group I v/s group II comparison, the mean and median values of mean reaction time was greater in older individuals (group II) than younger individuals (group I).

It can be inferred that older individuals have delayed processing of information which leads to greater mean reaction time as evident on tasks of divided attention. Lesser accurate responses can be attributed to greater demand of attention ability to focus on more than one stimulus at a given time. Higher complexity may have resulted in lesser accuracy scores (%). Even though gender difference was not considered as main objective of the study, during analysis it was noted that females had greater mean reaction time in older adults and females were more accurate than males in older group. However this finding is not supported through studies. Supporting research studies are not present for this inference.

As the next objective involves comparison across the tasks, performance of participants with respect to each task will be explained in the following objective.

b) Comparison of two attention tasks within each group.

Older adults had greater mean reaction time compared to younger adults while younger adults had greater accuracy score compared to older adults. Hence the next objective is to compare performance of older adults across the two tasks that were used in the current study. Table 7, gives mean, median and standard deviation scores of reaction time and accuracy score of older adults in two tasks of selective attention and two tasks of divided attention respectively (SA1, SA2, DA1 and DA2).

Table 7: Mean reaction time (ms) and accuracy score (%) across the tasks of selective and divided attention in group II participants.

Group	Gender	Parameters measured	Mean Reaction Time(ms)				Accuracy score (%)			
			SA1	SA2	DA1	DA2	SA1	SA2	DA1	DA2
II (Older)	Males	Mean	1661.69	619.11	650.89	554.93	65.44	83.82	86.26	87.50
		SD	311.193	313.61	314.93	146.70	23.98	13.83	12.19	5.00
		Median	1689.99	509.76	460.37	546.50	70.00	89.60	90.00	87.50
	Females	Mean	1710.74	627.39	613.63	533.44	70.66	93.30	90.52	86.33
		SD	484.31	236.84	253.92	145.41	20.25	6.044	7.32	12.31
		Median	1863.25	563.44	582.94	517.25	80.00	93.10	92.50	90.00

On comparison of mean reaction time across tasks of attention like SA1, SA2, DA1 and DA2 it was noticed that SA1 had greater mean reaction time in both the genders. Less Accuracy score was observed in SA1 than the other tasks of attention in both the genders. Mean and median value for both reaction time and accuracy score followed the same pattern. Older females had greater mean reaction time and greater accuracy score compared to older males in all the tasks of attention. It can be inferred from the mean reaction time and accuracy scores that the selective attention task 1 was more complex than selective attention task 2 and the both tasks of divided attention

Further statistical analysis was carried out using Wilcoxon signed rank test to compare the performance of the selective and divided attention tasks in various combinations with respect to group II. Individual analysis was carried for mean reaction time and accuracy score. The tables below (no.8) represent mean reaction time and accuracy score in group II individuals (males and female) across pairs of attention tasks.

Table 8: Z score of Wilcoxon Signed rank test for mean reaction time (ms) in group II males.

	Test Statistics	
	Z	Asymp. Sig. (2-tailed)
SA2RT - SA1RT	-3.408	.001
DA1RT - SA1RT	-3.408	.001
DA2RT - SA1RT	-3.408	.001
DA1RT - SA2RT	-.284	.776
DA2RT - SA2RT	-.511	.609
DA2RT - DA1RT	-.795	.427

Note: SA1-selective attention task 1, SA2- selective attention task 2, DA1- divided attention task 1, DA2-divided attention task 2 and RT-reaction time.

Older group individuals (group II) also showed a significant difference statistically with respect to mean reaction time. The |Z| scores of 3.408 ($p<0.05$) was obtained for SA2-SA1, DA1-SA1 and DA2-SA1 pairs in males showed statistically significant difference. Other combinations like DA1-SA2, DA2-SA2 and DA2 -DA1 did not show any statistically significant difference with |Z| values 0.284 ($p>0.05$), 0.511($p>0.05$) and 0.795 ($p>0.05$) respectively.

Table 9: Z score of Wilcoxon signed rank test for mean reaction time (ms) in group II females.

	Test Statistics	
	Z	Asymp. Sig. (2-tailed)
SA2RT - SA1RT	-3.351	.001
DA1RT - SA1RT	-3.294	.001
DA2RT - SA1RT	-3.408	.001
DA1RT - SA2RT	-.284	.776
DA2RT - SA2RT	-1.193	.233
DA2RT - DA1RT	-.682	.496

The |Z| score of 3.351 ($p<0.05$) , 3.294 ($p<0.05$) , 3.408 ($p<0.05$) for pairs of tasks like SA2-SA1 , DA1-SA1 and DA2-SA1 respectively observed to have statistically significant difference in older females with respect to mean reaction time. While |Z| score of 0.284 ($p>0.05$), 1.193 ($p>0.05$) and 0.682 ($p>0.05$) was obtained for pair wise comparisons of DA1-SA2, DA2-SA2 and DA2-DA1 respectively depicting no statistically significant difference.

Mean reaction time results for older group varied across the tasks of attention. Significant difference was seen in for the older group individuals on majority of task wise comparisons. This can also be attributed to age related changes in speed of processing (Salthouse 1996), poor inhibitory function or due to poor working memory capacity (Craik, Morris &Gick, 1990).

Further analysis was carried out with Wilcoxon signed rank test for accuracy scores across the tasks of selective and divided attention in older group. Table 10 and 11 represent accuracy scores of older females and males in pairs of tasks respectively.

Table 10: Z score of Wilcoxon signed rank test for accuracy score (%) in group II females.

Test Statistics		
	Z	Asymp. Sig. (2-tailed)
SA2AC - SA1AC	-3.124	.002
DA1AC - SA1AC	-2.704	.007
DA2AC - SA1AC	-2.672	.008
DA1AC - SA2AC	-2.954	.003
DA2AC - SA2AC	-1.761	.078
DA2AC - DA1AC	-.473	.637

Note: AC- Accuracy

The pairs of tasks which showed statistically significant difference with |Z| score of 3.124 ($p<0.05$), 2.704 ($p<0.05$) , 2.672($p<0.05$) and 2.954 ($p<0.05$) were SA2-SA1, DA1-SA1, DA2-SA1 and DA1-SA2 pairs respectively. Other pairs included DA2-SA2 and DA2-DA1 with |z| score of 1.761 ($p>0.05$) and .0473 ($p>0.05$) showed no statistically significant difference. Wilcoxon signed rank test was used to verify if there was any statistically significant difference for older males as well. The table below represents Z scores obtained across the pairs of attention tasks for older males.

Table 11: Z score of Wilcoxon signed rank test for accuracy score (%) group II males.

	Test Statistics	
	Z	Asymp. Sig. (2-tailed)
SA2AC - SA1AC	-2.158	.031
DA1AC - SA1AC	-2.923	.003
DA2AC - SA1AC	-3.015	.003
DA1AC - SA2AC	-.114	.910
DA2AC - SA2AC	-.682	.495
DA2AC - DA1AC	-.773	.440

In older males task pairs DA1-SA1 and DA2-SA1 depicts statistically significant difference was noticed with |Z| value 2.923 ($p<0.05$) and 3.015 ($p<0.05$) respectively. The |Z| value of 2.158 ($p>0.05$), 0.114 ($p>0.05$), 0.682 ($p>0.05$) and 0.773 ($p>0.05$) had no significant difference statistically in SA2-SA1, DA1-SA2, DA2-SA2 and DA2-DA1 respectively. Statistically significant difference was found for majority of task wise comparisons. In general older group individuals had greater difficulty for all the tasks. Among the older adults, both females and males had significant difference in accuracy scores when task 1 of selective attention was compared with other tasks

Statistically significant difference in accuracy score was seen on majority of tasks. This can be attributed to poor judgmental abilities in older individuals. Judgmental skills are expected to be better in older adults due to experience compared to younger adults but in current study accuracy score was poor in older adults (males and females). However this finding cannot be generalized.

Additional statistical analysis was carried out for younger males and females as well. Table 12, gives mean, median and standard deviation scores of reaction time and accuracy score of younger adults in two tasks of selective attention and two tasks of divided attention respectively (SA1, SA2, DA1 and DA2).

Table 12: Mean reaction time (ms) and accuracy score (%) across the tasks of selective and divided attention in group I participants

Group I (Younger)	**Gender**	**Parameters measured**	**Mean reaction Time**				**Accuracy score**			
			SA1	**SA2**	**DA1**	**DA2**	**SA1**	**SA2**	**DA1**	**DA2**
	Males	Mean	972.63	496.46	478.88	459.37	86.00	93.32	85.33	95.16
		SD	316.06	121.36	97.07	147.38	14.90	5.65	8.54	3.59
		Median	1071.00	483.73	495.21	491.60	90.00	93.10	87.50	95.00
	Females	Mean	1098.38	545.97	491.70	470.62	91.66	95.05	86.87	95.66
		SD	255.35	141.53	128.51	149.32	6.98	3.12	7.44	2.74
		Median	1102.50	523.87	430.47	450.80	95.00	96.00	87.50	95.00

Mean reaction time (ms) for first task of selective attention (SA1) was more compared other tasks of attention (SA2, DA1 and DA2) in younger adults. While accuracy score in younger participants varied across tasks and did not follow any uniform pattern as in older adults except that the mean reaction time was more and accuracy was less for SA 1 similar to group II (older participants). Mean and median values were in proportion. Younger females had greater mean reaction time compared to males in tasks of attention whereas younger males had lesser accuracy score than females in all tasks of attention. From the above results we can infer that, due to increase in complexity in first task of selective attention mean reaction time was observed to be more in group I participants.

Further statistical analysis was carried out using Wilcoxon signed rank test to compare the performance of the selective and divided attention tasks in various combinations in group I individuals. Pair wise analyses were carried for different tasks for both mean

reaction time and accuracy scores. The tables below represent mean reaction time and accuracy score in group I individuals (males and female) across pairs of attention tasks.

Table 13: Z scores of Wilcoxon signed rank test for mean reaction time in group I males.

	Test Statistics	
	Z	Asymp. Sig. (2-tailed)
SA2RT - SA1RT	-3.181	.001
DA1RT - SA1RT	-3.124	.002
DA2RT - SA1RT	-3.294	.001
DA1RT - SA2RT	-.398	.691
DA2RT - SA2RT	-.227	.820
DA2RT - DA1RT	-.511	.609

For group I, statistically significant difference was noticed for SA2-SA1 pair, DA1-SA1 pair and DA2-SA1with |Z| values of 3.181 ($p<0.05$) , 3.124 ($p<0.05$) and 3.294 ($p<0.05$) respectively. The |Z| value of 0.398 ($p>0.05$) , 0.227 ($p>0.05$) and 0.511 ($p>0.05$) was obtained for DA1-SA2 , DA2-SA2 and DA2-DA1 respectively indicating no statistically significant difference.

Table 14: Z score for Wilcoxon signed rank test for mean reaction time in group I females.

	Test Statistics	
	Z	Asymp. Sig. (2-tailed)
SA2RT - SA1RT	-3.408	.001
DA1RT - SA1RT	-3.351	.001
DA2RT - SA1RT	-3.408	.001
DA1RT - SA2RT	-.852	.394
DA2RT - SA2RT	-1.363	.173
DA2RT - DA1RT	-.511	.609

The |Z| scores for mean reaction time for younger females are 3.408 ($p<0.05$) for SA2-SA1 pair and DA2- SA1 pair and 3.35 ($p<0.05$) for DA1-SA1 pair shows statically significant difference while |Z| scores of DA1-SA2 , DA2-SA2 and DA2-DA1 pairs are 0.852($p>0.05$) , 1.363 ($p>0.05$) and 0.511 ($p>0.05$) respectively revealed no statistically significant difference. It can be noted from the above observations, that statistically significant difference was seen for the pairs which involved SA1. This could be because selective attention task 1 was more complex than the other tasks used to tap attention.

The tables mentioned below represent accuracy scores for group I individuals across the pairs of tasks of attention.

Table 15: Z score of Wilcoxon signed rank test for accuracy score (%) in Group I males.

Test Statistics		
	Z	Asymp. Sig. (2-tailed)
SA2AC - SA1AC	-3.464	.062
DA1AC - SA1AC	-2.346	.077
DA2AC - SA1AC	-2.892	.098
DA1AC - SA2AC	-2.329	.163
DA2AC - SA2AC	-1.382	.098
DA2AC - DA1AC	-2.672	.217

Accuracy scores of younger males across pairs of tasks like SA2-SA1, DA1-SA1, DA2-SA1, DA1-SA2, DA2-SA2 and DA2-DA1 are represented with the |Z| value of 3.464($p>0.05$), 2.346($p>0.05$),2.892($p>0.05$), 2.329($p>0.05$), 1.382 ($p>0.05$) and 2.672($p>0.05$) respectively in the above table ,indicating no statistically significant difference.

Table 16: Z score of Wilcoxon Signed rank test for accuracy score (%) in Group I females.

Test Statistics		
	Z	Asymp. Sig. (2-tailed)
SA2AC - SA1AC	-1.761	.078
DA1AC - SA1AC	-2.268	.096
DA2AC - SA1AC	-3.468	.121
DA1AC - SA2AC	-2.954	.003
DA2AC - SA2AC	-1.571	.064
DA2AC - DA1AC	-.673	.457

The |Z| value of 1.761 ($p>0.05$) 2.268 ($p>0.05$), 3.468 ($p>0.05$), 2.954 ($p>0.05$), 1.571 ($p>0.05$) and 0.673 ($p>0.05$) was obtained for pairs of tasks like SA2-SA1, DA1-SA1, DA2-SA1, DA1-SA2, DA2-SA2 and DA2-DA1 respectively from Wilcoxon signed rank test. The results indicated no significant difference statistically in accuracy score for younger females across pairs of tasks.

From the above analysis we can infer that only when task 1 of selective attention was paired with other tasks of attention (task 2 of selective attention and two tasks of divide attention) statistically significant difference was noticed. This result can be attributed to complexity of task 1 of selective attention.

As task 1 of selective attention was complex and taxed more cognitive abilities of individuals even in younger groups statistically significant difference was noticed with respect to mean reaction time and accuracy score when task 1 of selective attention was paired with other tasks of attention.

In summary, the first objective was to compare the performance of attention process between group I and group II individuals. The performance was determined through mean reaction time and accuracy scores. Statistically significant difference was seen between the two groups as evident on Mann-Whitney U test. This shows that the attentional abilities may decrease with age. The second objective was to compare the performance of participants across the tasks of attention (selective and divided). Within group II there was a statistical significant difference as evident on Wilcoxon signed rank test observed when the tasks of attention was compared in various combinations. While in group I statistical significant difference was seen when a given task of attention was compared with selective attention task 1 (SA1). Selective attention task 1 used Navon's letters and required the participants to give a stipulated response for congruent and incongruent trials. This task proved to be a complex task for both younger as well as older adults. The other task that is SA2, DA1 and DA2 was found to be equal in terms of its complexity. In terms the order of complexity between the remaining three tasks DA2 was more complex than DA1 followed by SA1. Comparing selective attention versus divided attention the mean reaction time and accuracy score showed that selective attention required more cognitive load compared to divided attention. The findings obtained in the present study are not supported through parallel studies as the present study is the first of its kind to use a novel linguistic paradigm.

Chapter V

Summary and Conclusions

Cognition is stated by Matlin (2005) as “a mental activity which describes the acquisition, storage, transformation and use of knowledge". A set of mental abilities including attention, memory, perception, reasoning and others can be collectively referred as cognition. These cognitive processes have greater contribution in everyday life situations. Cognitive abilities are individual specific and declines with aging.

Attention is one of the major cognitive processes which play an important role in processing information in the environment. As quoted by Shapiro in 1994 “ Attention is a kind of concentration on a mental task in which individuals select certain kinds of perceptual stimulator for further processing, while trying to exclude other interfering stimuli”. A wide variety of activities are carried out in our day to day life and based on this we can classify attention in to three types. Selective attention is the process of focusing on relevant information while ignoring the irrelevant one is termed as explained by Kellorg (2007). While sustained attention can be described as being focused for prolonged period of time to the stimulus in environment, whereas the most taxing type of attention is divided attention. This requires alertness for more than one kind of stimulus present in surrounding. In speech and language processing, attention plays a major role in selection of information in the context as well as maintaining the same for a prolonged period.

Unlike other cognitive processes attention also varies across age groups. Older adults tend to have decline in attention process as age increases (Commodari,,& Guarnera,,2008). Age related changes were noticed especially in prefrontal and parietal cortices for attention control (Milham et al in 2002). As investigated by Girelli in 2001, Lemos and Daniel in 2013, Commaodari and Guarenera in 2013 and various other researchers, a decline in attention process was noticed in older adults compared to younger adults under various methods of investigation that taps attention processes.

However there is dearth of literature in terms of linguistic investigation of attention processes. Hence the current study was planned. The study aims to throw light on selective and divided attention span across younger and older adults. Study involved standard group comparison paradigm which involved 60 bilingual participants. Tasks were designed in L2 of the participants to tap attention processes (selective and divided).

The selective attention was assessed through two tasks: the first task used Navon's letter, presented via congruent and incongruent trials (congruent trails had constituent letters same as the target letter, while the incongruent trials had different constituent letters unlike the target letter) the second task used letter monitoring task with the letter 'P' as the target letter. 40 words comprising of target letter and catch trails were randomized and presented through DMDX software.

Even for assessing divided attention two tasks were employed; First task involved letter monitoring task similar to the task used for assessing selective attention but this task used two target letters 'B' and 'T' unlike the task of selective attention which used one target letter. A set of 40 words with the two target letters and catch trails were presented through DMDX. Task 2 used 40 ANT pictures synchronized with matching phrases (phrases describing the pictures correctly) and non-matching phrases (phrases describing the pictures incorrectly). The stimulus for selective attention task 2 was recorded using PRAAT software and were presented to the participants through headphone by employing DMDX software again. The mode of presentation for divided attention task 2 was both auditory and visual while the mode of presentation for selective attention task 1 (Navon's latter) was visual and for the other two tasks (selective attention task 2 and divided attention task 1) the mode of presentation was auditory. The obtained data was analyzed in terms of mean reaction time and accuracy score.

The first objective of the study was to compare selective and divided attention process across younger and older groups. Mean, median and standard deviation for both mean reaction time and accuracy score was compared for the two groups. Statistically significant difference was seen on Mann Whitney U test (as the data did not abide by the properties of normal distribution) between younger and older groups for both mean reaction time and accuracy scores. This result showed that attention processes (selective and divided attention) differ in younger and older adults.

The second objective was to compare tasks of attention used in the study across the older group. Mean median and standard deviation for both mean reaction time and accuracy score was computed. Task 1 of selective attention demanded higher reaction time compared to the other tasks tapping attention. Further analysis was carried out using Wilcoxon sign rank test and attention tasks were compared in a pairwise manner. Statistically significant difference was noticed in mean reaction time when first task of selective attention was paired with other tasks. Even on accuracy of scores, the Z scores indicated statically significant difference when first task of selective attention was paired with other tasks of attention. The first task of selective attention was complex compared to other tasks of attention.

Additional analysis was carried out in the younger group to verify if there was any significant difference between the tasks used. There was statistically significant difference evident on Wilcoxon's signed rank test when the first task of selective attention was clubbed with any other task. Henceforth the study helps to infer that like other cognitive processes, attention capacity also declines with age. The decline also varied based on the complexity of the task. From this study we can also understand the influence of attention in language processing.

Implications of the study

a) The current study helps to understand age related changes in attention process assessed using linguistic paradigm. The results of the study indicate age related changes in attention processes (selective and divided), thus helps to be vigilant on age related changes in older population.

b) This study also builds a connection between attention processes and language, as participants were assessed in their L2 (English) and complexity of tasks designed. Inferring that task of higher complexity taxes more attention compared to lesser complex task, which is one of the factors affecting attention. Hence either while assessing or during course of treatment for attention processes these factors need to be controlled and planned as per the age of the individual.

Limitations of the study

a) The current study included only 60 participants and only two age groups of individuals (18-25 years and 55-65 years) were considered. Inclusion of middle aged group individuals would have given a better insight for reflecting decline in attention process.

b) Study was carried out in L2 (English) of participants in order to induce more complexity. Usage of first language (Kannada) to study attention process would have revealed the difference in the performance under the two conditions (L1 v/s L2) which in turn would unveil the relationship between attention and language.

c) The modality of presentation was different for different tasks employed. The modality of presentation would have been kept uniform as it would influence the reaction time.

Future directions

a) Test stimulus can be framed in such way that uniformed complexity can be maintained across tasks in future studies.

b) Study can be carried out in larger population and across age groups to have a better picture of decline in attentional process.

c) Different tasks can have the same modality of presentation.

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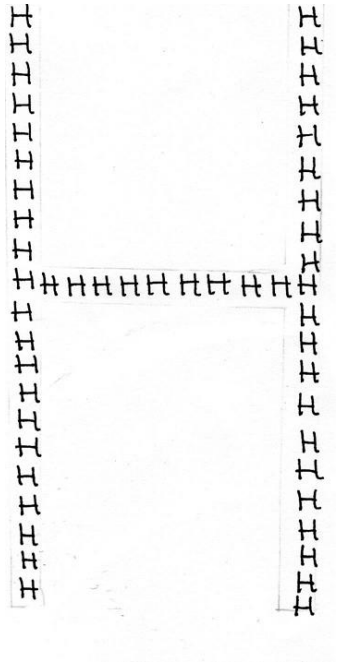
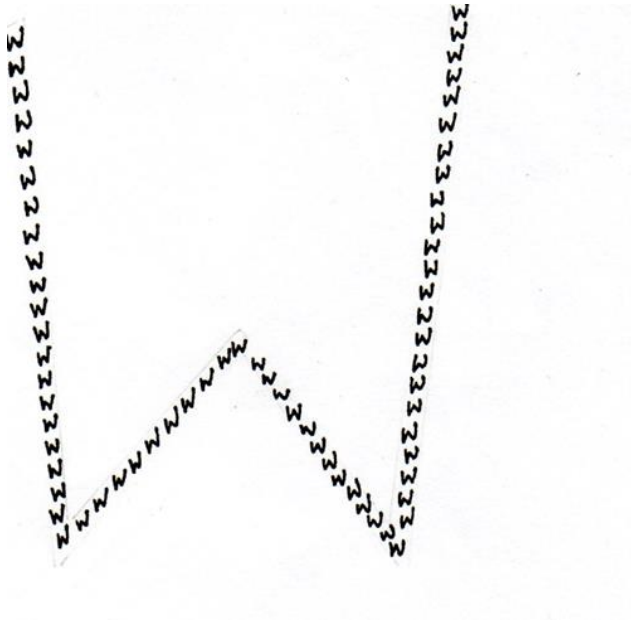
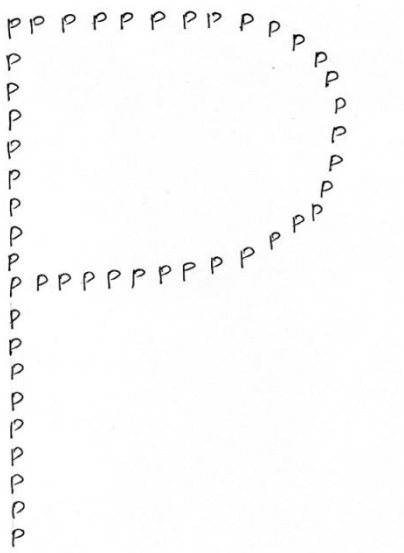
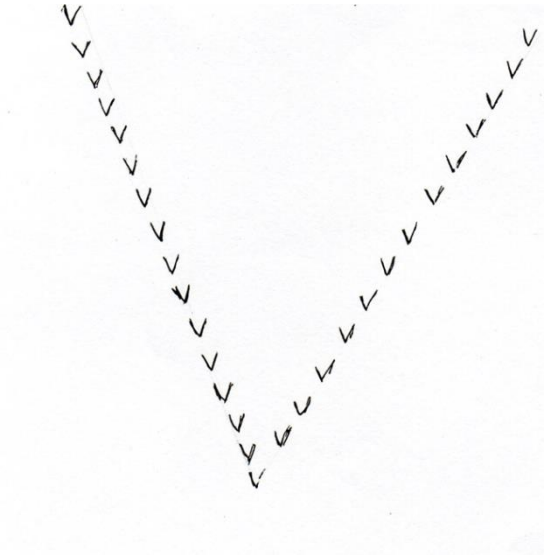
Appendix I

Stimulus for selective attention task 1- navon's figures









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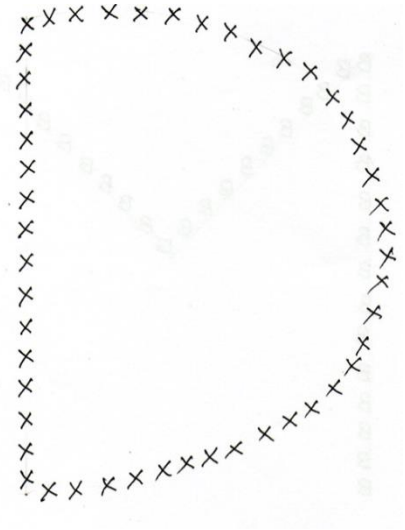
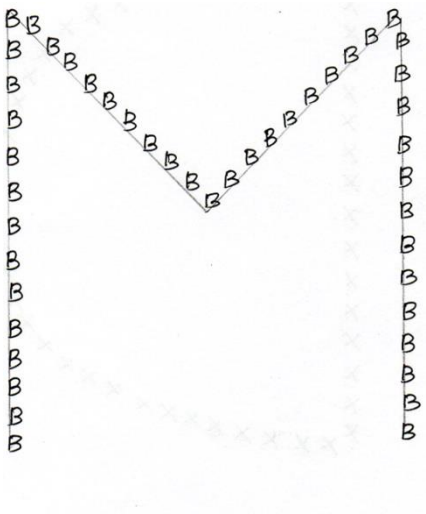
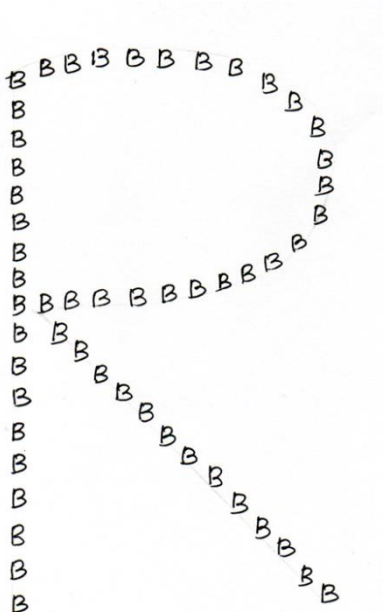
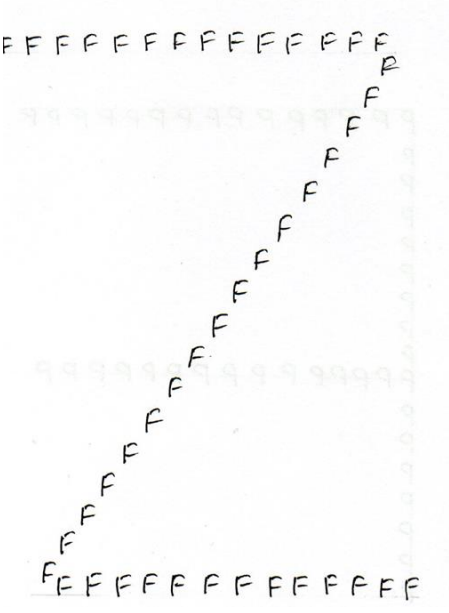
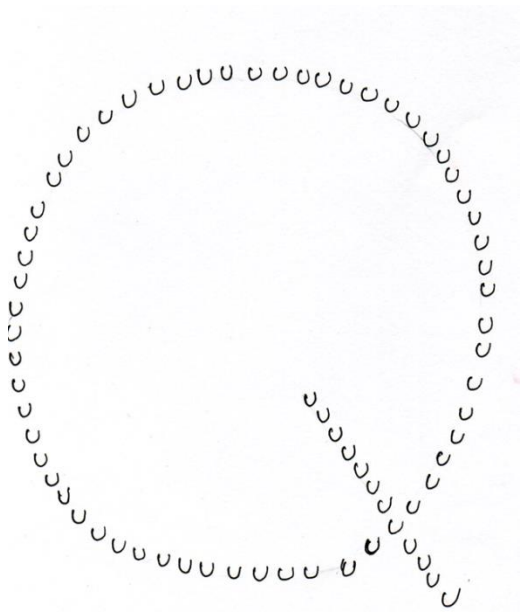
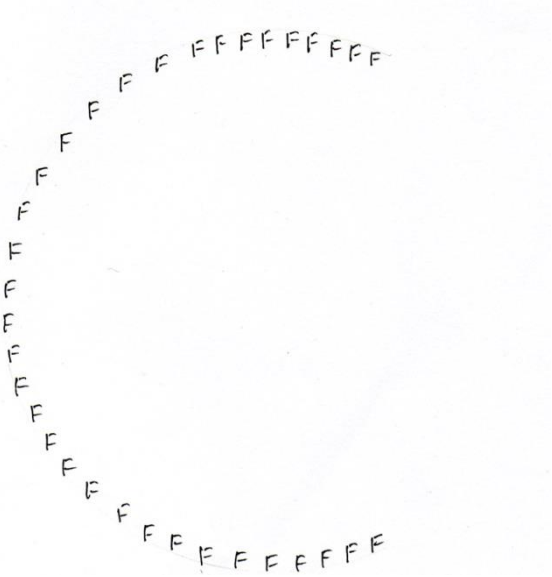


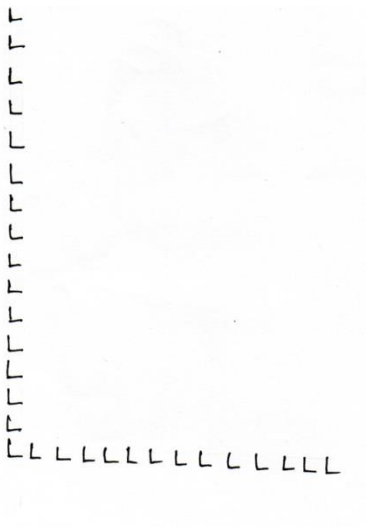


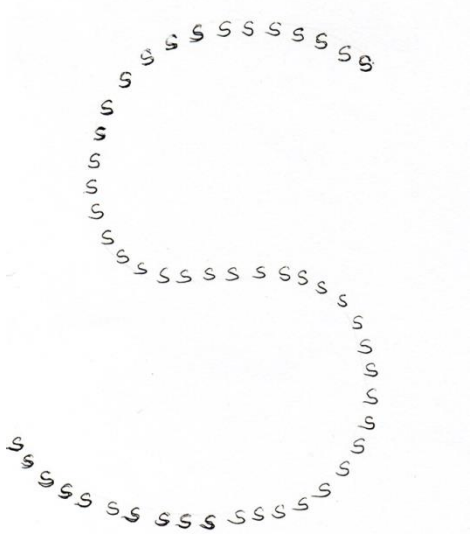


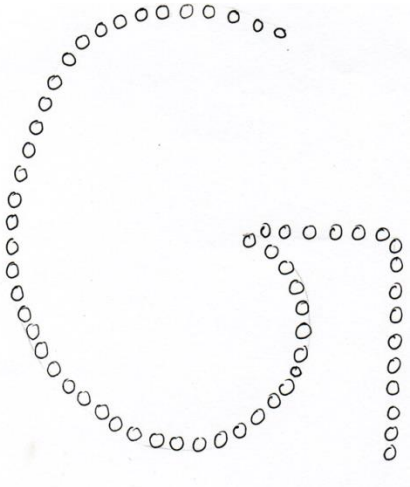


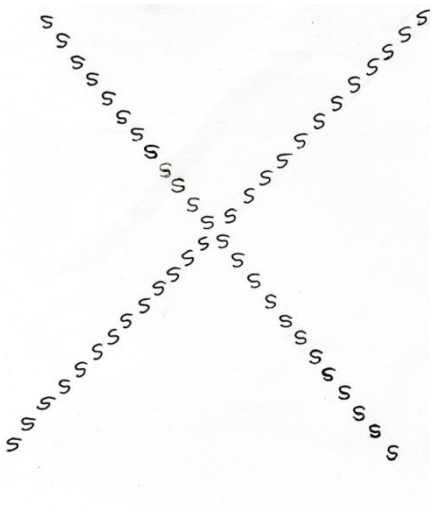












Appendix -II

Word list used for selective attention task 2.

- Drop
- Clip
- Pain
- Scale
- Hippo
- Pig
- Cop
- Mask
- Rocket
- Print
- Ear
- Basket
- Key
- Pole
- Wrapper
- Table
- File
- Keep
- Zip
- Plan
- Pot
- Grass
- Pack
- Light
- Pen
- Park
- Wire
- Cupboard
- Ink
- Deep

Appendix III

Word list used for divided attention task 1.

Band

Club

Screen

Leaf

Plumber

Buy

Film

Bank

Web

Boy

Mirror

Rub

Blade

Mark

Cable

Long

Bill

Lamp

Run

Orange

Bus

Car

Humble

Tea

Arrow

Camera

Slit

Pack

Type

Force

Token

Time

Shatter

Window

Top

Fit

Vase

Sit

News

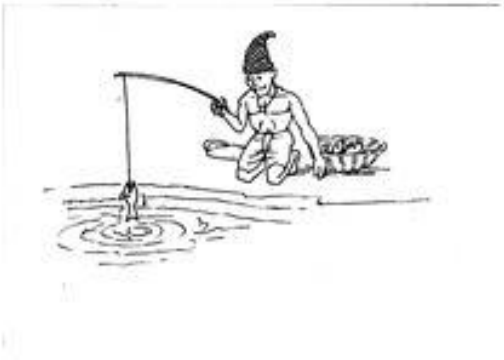
Cat

Appendix IV

Stimuli used for second task of divided attention.

He is eating an apple.

Drinking milk.



He is fishing.

Boy is crying.

Kicking the ball.

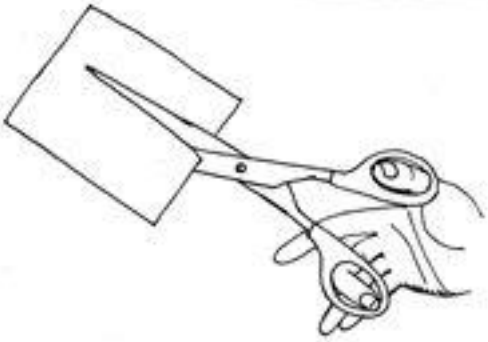
Climbing tree

Sleeping on a mat.

Pointing towards you.

Boy is swimming.

Girl swings.



Cutting paper.

Running on road.

Writing on a paper.

They are greeting.

Throwing the ball.

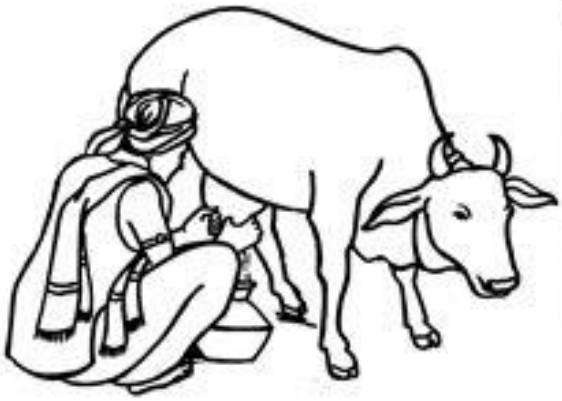
Flying high

Taking bath.

Man is smoking.

Sitting on a chair.

Reading book.



Praying to god.

Water is dripping.

Doing ercercise.

Man is digging hole.

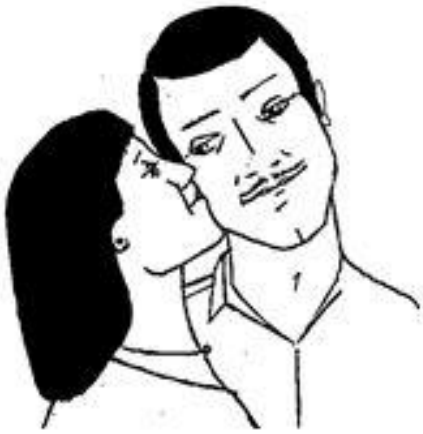
Stitching new dress.

Lifting heavy object.

Burst like volcano.

Reading a novel.

Girl is dancing.



Mother is sweeping.

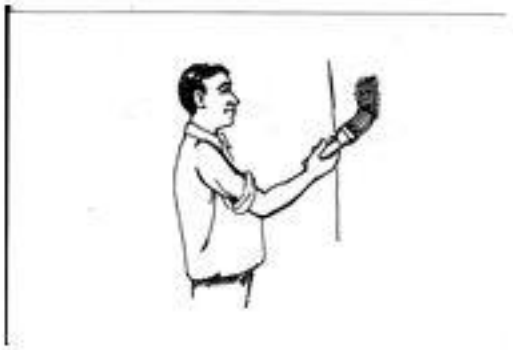
He is cutting.

She propose..

He winks at her..

man loves pet animals.

He won the match.



Blowing a balloon.

Saluting officer.

Dog is barking.

Falling from tree.

She is worried.