The International Journal of Indian Psychology
ISSN 2348-5396 (Online) | ISSN: 2349-3429 (Print)
Volume 14, Issue 2, April- June, 2026
DIP: 18.01.141.20261402, DOI: 10.25215/1402.141
https://www.ijip.in

Review Paper

Plan-Ex and Cognitive Aging: A Review of Executive Processes in Later Adulthood

Dr. Gopangana Das[1]*

ABSTRACT

This review examines the interplay between planning and executive functions in the context of cognitive aging. Drawing on theoretical models and empirical findings, the paper explores how core executive processes such as, working memory, cognitive flexibility, and inhibitory control contribute to effective planning and how these abilities change with age. Evidence from neuropsychological tasks, such as the Tower of London and Multiple Errands Test, highlights the challenges older adults face in both formulating and executing plans, with age-related declines often linked to processing speed, task complexity, and diminished executive resources. The review discusses inconsistencies in research findings and underscores the importance of nuanced assessment methods that capture real-world functioning. Ultimately, understanding the relationship between planning and executive function in later adulthood can inform targeted interventions to help older adults maintain independence, adapt to novel situations, and enhance their quality of life. Planning and executive function are closely interconnected, as effective planning relies heavily on various components of executive function. Executive functions encompass cognitive processes such as working memory, inhibitory control, and cognitive flexibility, all of which play a crucial role in setting feasible goals, strategizing steps to achieve them, and adjusting plans as needed. When individuals engage in planning, they draw on their ability to anticipate future outcomes, evaluate potential obstacles, and prioritize tasks. Conversely, a well-structured plan can enhance executive function by providing a clear framework for action, which helps to streamline decision-making and improve problem-solving skills. The relationship between planning and executive function is synergistic, as each supports and enhances the other in navigating complex tasks and reaching desired objectives. Understanding the role of planning and executive function in the aging process is crucial for grasping how cognitive abilities evolve over time. As individuals age, these cognitive processes may undergo significant changes, impacting not just personal independence, but overall quality of life.

Keywords: *Cognitive aging, planning, executive functioning, working memory, cognitive flexibility, attention inhibition*

Planning and executive function are closely interconnected, as effective planning relies heavily on various components of executive function. Executive functions encompass cognitive processes such as working memory, inhibitory control, and cognitive

[1]Assistant Professor, Department of Psychology, Shailabala Women's Autonomous College, Cuttack
*Corresponding Author

Received: May 9, 2026; Revision Received: May 25, 2026; Accepted: May 28, 2026

flexibility, all of which play a crucial role in setting feasible goals, strategizing steps to achieve them, and adjusting plans as needed. When individuals engage in planning, they draw on their ability to anticipate future outcomes, evaluate potential obstacles, and prioritize tasks. Conversely, a well-structured plan can enhance executive function by providing a clear framework for action, which helps to streamline decision-making and improve problem-solving skills. The relationship between planning and executive function is synergistic, as each supports and enhances the other in navigating complex tasks and reaching desired objectives. Understanding the role of planning and executive function in the aging process is crucial for grasping how cognitive abilities evolve over time. As individuals age, these cognitive processes may undergo significant changes, impacting not just personal independence, but overall quality of life.

Planning is an essential cognitive function that aids in the selection or creation of strategies required to solve problems, playing a crucial role in tasks demanding problem-solving abilities for both children and adults. It encompasses the entire process of generating, evaluating, and executing a plan, along with self-monitoring and impulse control. Through planning, individuals can effectively tackle problems, exercise control over attention, manage simultaneous and successive processes, and selectively apply their knowledge and skills. This multifaceted cognitive process is instrumental in problem-solving activities (Das, Kar, & Parrila, 1996). However, with cognitive aging, these processes can be significantly affected. As aging occurs, individuals may experience declines in various cognitive domains, such as executive functions, which are critical for effective planning. This decline can hinder the ability to generate coherent plans and execute them efficiently (Zelinski et.al., 2011).

A functional analysis, proposed by Grafman (1989) and Shallice (1982), breaks planning into two complementary functions: accommodative (bottom-up activity) for formulating plans and assimilative (top-down activity) for executing plans. The former allows strategy development based on environmental influences, while the latter involves implementing plans in response to the situation. Cognitive aging can impair both functions, as old age group may struggle to adapt their strategies based on new information, leading to difficulties in both formulating effective plans and carrying them out successfully. Recent theoretical model, dual-level process of planning aligns with older research and suggest that planning consists of two levels: formulation (developing the strategy) and execution (carrying it out). Cognitive aging affects both levels, as old age group may have a diminished capacity for logical strategy development and monitoring the execution of these plans (Park & Reuter-Lorenz, 2009). This dual-level impairment can lead to ineffective problem-solving, further exacerbating the difficulties faced in managing daily activities. Old age group, inability to quickly process environmental cues also make them struggle to adjust their plans effectively. Aarts et al., (1999) emphasized that successful planning relies on being attuned to the environmental context where goals are pursued. The decreased environmental awareness among old age group can hinder their ability to implement plans successfully, further impacting their daily functioning.

Planning, as a cognitive process, plays an important role in our daily life, influencing how we approach tasks and make decisions (Das, Kar, & Parrila, 1996; Luria, 1966). It is not just an abstract concept; rather, it is woven into the fabric of our voluntary behaviors. This means that whether we are deciding what to have for dinner or strategizing our career path, planning is at the heart of these decisions. Luria (1978) emphasized that planning requires organizing our actions in relation to a specific goal. This organization typically unfolds through a sequence of intermediate steps, which act as building blocks toward achieving the final objective. In essence, effective planning can be viewed as a sophisticated problem-solving ability (Luria, 1973). It allows individuals to break down complex tasks into manageable parts, facilitating systematic progress. However, as individuals age, they may experience certain cognitive declines, particularly in working memory and processing speed (Salthouse, 1991). These declines can significantly impact an old age's capacity to plan effectively. For example, organizing a simple task such as budgeting can become challenging if one's working memory cannot hold all the necessary information at once. Similarly, planning social engagements may require sequencing multiple steps. The implications of these challenges are far-reaching. Old age group' struggle with not only financial management but also keeping up with social connections or adapting to new technologies that require forethought can essentially be related to decrease in the planning ability.

The role of brain damage in relation to decrease planning ability has been studied extensively. Planning impairments associated with frontal lobe damage have been the focus of various studies aimed at understanding how these brain regions contribute to executive functions. The Tower of London task and the Multiple Errands Test are both significant in assessing the cognitive abilities linked to planning, particularly in individuals with frontal lobe damage. The Tower of London task, introduced by Shallice in 1982, is a classic neuropsychological test designed to evaluate executive functions, specifically planning. The task involves moving colored disks across pegs to reach a predetermined configuration, requiring the participant to think several steps ahead and consider the rules governing the movement of the disks. The complexity of this task lies in the need to plan effectively while avoiding unnecessary moves, thus reflecting real-life decision-making challenges where an individual must juggle multiple factors and constraints. Research using the Tower of London task has consistently indicated that individuals with frontal lobe damage tend to struggle significantly with this task compared to their non-brain-damaged counterparts, leading to insights into how executive dysfunction can affect every day planning skills.

On the other hand, the Multiple Errands Test, developed by Shallice and Burgess in 1991, expands the assessment of planning abilities into more naturalistic settings. This test simulates real-life scenarios where individuals are required to complete a series of errands in a familiar environment, such as a shopping centre or a hospital. Participants must not only accomplish tasks but also manage time constraints, navigate distractions, and coordinate multiple actions simultaneously. The essence of the Multiple Errands Test lies in its ecological validity, as it emphasizes how frontal lobe impairments can hinder an individual's ability to plan and carry out everyday tasks in dynamic and unpredictable settings. Studies have shown that individuals with frontal lobe damage exhibit notable deficits in this test, often forgetting tasks, failing to prioritize effectively, and becoming overwhelmed by the environment's demands. Together, these studies underscore the critical role of the frontal lobes in facilitating higher-order cognitive processes such as planning and problem-solving. The consistent findings from both the Tower of London task and the Multiple Errands Test illustrate that individuals with frontal lobe damage may not only struggle with constructing complex plans but also with executing those plans effectively in practical contexts.

Many research on planning performance in healthy elderly participants have garnered attention, yet findings remain varied and sometimes conflicting. These body of research reflects the complexity of cognitive aging, particularly in the domain of executive functions, which are crucial for effective planning as well as decision-making.

Brennan, Welsh, and Fisher (1997) conducted a comprehensive study to explore the impact of age on planning abilities, utilizing the Tower of Hanoi task—a classic problem-solving activity that requires strategic thinking and the use of executive functions. The study analysed three distinct age groups: 12 young group with a mean age of 19, 9 middle-aged group with a mean age of 65, and 10 old age group with a mean age of 75. The findings revealed notable differences in executive functioning across these groups, particularly when comparing performances on simpler versus more complex versions of the task. In the initial phase of the experiment, where participants were required to solve a three-disk challenge, both the young group and the middle-aged group displayed comparable executive function capabilities. However, the oldest group struggled significantly more, suggesting a decline in cognitive processing linked to aging. As the task complexity increased with the introduction of a fourth disk and extended move sequences, the discrepancies in performance among the age groups became even more pronounced. The young group excelled, clearly outperforming the older cohorts. This observation led the authors to propose two primary explanations for their results. First, they posited that the observed decline in executive function skills is a characteristic of aging, particularly affecting the ability to plan and execute multi-step tasks. Second, they suggested that as tasks become more complex, the demands on executive functioning increase, specifically highlighting processing speed as a crucial component. Old age group may find it more challenging to meet these heightened demands due to age-related cognitive decline.

One of the earlier studies, conducted by Brennan, Welsh, and Fisher in 1997, utilized the Tower of Hanoi task to explore planning abilities across age groups. This task, which involves moving disks across pegs with the aim of achieving a specific arrangement while following specific rules, revealed that elderly participants displayed notable differences in planning performance when compared to their younger counterparts. The use of the four-disk version of the task highlighted these deficits, suggesting that age-related decline may impact the ability to formulate and execute multi-step plans.

In contrast, research by Allain et al. in 2005 examined planning capabilities using the Tower of London task, which also emphasizes strategic planning through a different set of criteria. In their study, they found no significant differences between young and elderly adults with respect to planning capacities. This inconsistency between the two studies indicates that specific task demands, as well as the inherent cognitive components measured, can influence outcomes. It underscores the importance of considering the nuances of each test when assessing cognitive performance across different age groups.

Furthermore, ecological tasks that simulate real-life conditions have been increasingly recognized for their relevance in understanding cognitive functions among the elderly. Guimond et al., (2006) provided vital insights through a study that employed a real-life simulation of daily activities. Their findings indicated that old age group exhibited impairments in dimensions such as anticipation-planning and the ability to shift attention between ongoing tasks. These results suggest that while elderly individuals may retain some cognitive flexibility, they often struggle with tasks that require dynamic planning and multitasking.

Continuing in this line of research, Allain et al. (2005) further investigated planning by utilizing the "Zoo Map Test," part of the Behavioural Assessment of the Dysexecutive Syndrome test battery. In a structured design, both formulation and execution phases of planning were assessed. The first trial was categorized as "high demand," where participants had to independently plan their route to visit designated locations in a zoo. In the second, "low demand" trial, participants were required to follow a predetermined strategy, easing the cognitive load. The results from this study provided critical insights: elderly adults experienced greater difficulties during the formulation phase compared to the execution phase. The result analysis effectively demonstrated that older participants had more challenges in developing logical strategies to navigate the task. Additionally, the difference between formulation and execution was more pronounced in elderly participants than in younger adults.

This outcome emphasizes that while old age group can efficiently implement existing plans, they often struggle to devise new and effective strategies when required to adapt to novel situations. These body of research reveals that while healthy elderly individuals retain some aspects of planning ability, particularly in executing predefined strategies, they face significant challenges in formulating complex plans and adapting to new demands.

Executive function (EF) initially termed as the "central executive" by Baddeley and Hitch (1974) and later defined by Lezak (1983), is the dimension of human behavior concerned with the expression of behavior. Comprising four key components—goal formation, planning, executing goal-directed plans, and effective performance—executive functions are crucial for appropriate, socially responsible, and self-serving adult conduct. Lezak, (1983) highlighted the role of intact executive functions in enabling individuals with substantial cognitive loss to maintain independence and productivity. These high-level cognitive functions are generally associated with the frontal lobes, as identified by Luria (1973), who emphasized the frontal lobes' essential role in organizing intellectual activity. Friedman et al. (2017) characterize executive function as higher level cognitive processes, typically linked to the frontal lobes which regulates lower-level processes to facilitate goal-directed behaviour. These processes encompass inhibition of response, controlling interference, updating working memory, and set shifting. The executive function is crucial for regulating behavior and cognitive processes in response to environmental feedback. It involves mental operations necessary for directing goal-oriented behaviors and handling complex, novel tasks. Stuss (1992) defines executive functions functionally as a set of complementary skills enabling the establishment and maintenance of goals in active memory, controlling performance and preventing potential distractions from interfering with goal achievement. In recent years, the exploration of EF, particularly in relation to cognitive aging, has gained prominence among researchers. This area of study merges insights from both neuropsychology and cognitive psychology, providing a deeper understanding of how executive functions change as we age and how these changes impact overall cognitive health and daily functioning.

Miyake et al. (2000) conducted a pivotal study that significantly advanced our understanding of executive functions, particularly through the lens of three core components: shifting, updating, and inhibition. Their research incorporated a robust sample of 137 young group and employed a series of tasks that were designed to isolate and examine these functions individually and in concert. Firstly, Shifting as a function is essential for cognitive flexibility, allowing individuals to switch their attention between tasks or adapt to new rules. In the study, participants engaged in tasks that required them to shift attention between different rules or problem-solving strategies. For instance, during a task requiring them to change the criteria for sorting objects, those with strong shifting abilities could adjust their approach quickly and efficiently to meet the new requirements. The results illustrated not only the critical role of shifting in task performance but also showcased how this flexibility

is foundational for navigating everyday situations that demand adaptability and adjustment. Secondly, updating is the ability to hold and manipulate information in working memory is vital for effective decision-making and task performance. In their tasks, participants were tested on their capacity to update and revise the information they were working with. For example, during a task where they had to keep track of a changing list of numbers or concepts, participants who excelled at updating displayed better overall performance. This emphasizes the importance of this function for managing real-time data, which is integral in complex cognitive tasks like writing, planning, or engaging in discussions where information evolves rapidly. Thirdly, inhibition refers to the capacity to suppress dominant or automatic responses in favour of more deliberate and thoughtful actions. The Tower of Hanoi was a focal task in this study, illustrating how individuals needed to resist simpler, impulsive moves to strategically navigate the puzzle toward a solution. The findings underscored the significance of inhibition as participants who could effectively inhibit their immediate tendencies performed better, reinforcing the idea that self-control and cognitive regulation are crucial in achieving successful outcomes in various tasks. The interconnectedness of these executive functions was a fundamental finding of Miyake et al.'s study. It suggested that deficits in one area could affect performance in others, thereby creating a broader impact on cognitive functioning. This complexity is essential to understand how these components work together to support higher-level cognitive abilities.
The findings from the individual differences study on executive functions have significant implications for understanding cognitive aging. As individuals age, shifts in the ability to perform tasks related to mental set shifting, updating, and inhibition may contribute to observed declines in complex cognitive functions. Understanding how these executive functions operate and their interrelationships can help researchers target specific areas for intervention and support in old age group, potentially mitigating the effects of cognitive decline.

Complementing Miyake's research, the work of Ridderinkhof et al., (2002) explored age-related changes in executive functioning. Their studies indicated that old age group exhibit a significant decline in these functions, particularly in shifting and flexibility. They found that as individuals age, there is a pronounced reduction in the ability to adapt to new information or change strategies, which can manifest in challenging everyday tasks such as navigation, switching between social topics, or adapting to new technologies. This research highlights how age can lead to increased rigidity in thinking and behavior, which may hinder an individual's ability to function optimally in rapidly changing environments.

Salthouse's (1996) hypothesis on processing speed further elucidates why these declines occur. He posited that cognitive aging is marked by slower processing speeds, meaning that old age group require more time to engage with and manipulate information. In practical terms, this slowdown could result in older individuals taking longer to respond to questions, process instructions, or switch tasks, all of which can impair performance in both simple and complex cognitive tasks. Salthouse's findings provide a framework for understanding the broader implications of cognitive decline as it relates to executive functioning, where increased time demands may lead to difficulties in reasoning, memory recall, and effective planning. His research has profound implications for how we understand the relationship between age and cognitive ability. It indicates that processing speed isn't merely a by-product of age; rather, it plays a fundamental role in the overall efficiency of executive functions, shaping the ability of old age group to perform on tasks that rely heavily on these cognitive processes.

Together, these studies create a comprehensive picture of executive functioning throughout the lifespan. They emphasize the importance of not only understanding these individual components but also considering how they interact and contribute to everyday functioning. As we age, recognizing the nature of these declines and their impact on cognition can inform strategies for supporting cognitive health, enhancing functional capabilities, and enriching the quality of life for old age group. Approaches could include cognitive training, brain health interventions, and fostering environments that minimize the cognitive load on individuals as they navigate the complexities of daily life.

Working Memory as a Component of Executive Function in Cognitive Aging

Working memory is a critical component of executive function, which encompasses a range of cognitive processes necessary for planning, attention, problem-solving, and decision-making. It refers to the ability to temporarily hold and manipulate information in the mind, allowing individuals to perform complex tasks that require the integration of multiple pieces of data. Studies have indicated that working memory may decline with age, impacting various facets of cognitive functioning. A comprehensive review of studies reveals how cognitive aging influences working memory, particularly focusing on the effects of processing speed, inhibitory efficiency, storage capacity, and memory load. Salthouse's pioneering work in 1994 established a foundational understanding of the age-related differences in working memory. His experiments demonstrated that old age group often struggle to achieve the same accuracy levels in tasks as younger individuals. Salthouse uncovered that this discrepancy is largely due to slower encoding processes rather than an increased rate of information loss. By manipulating presentation times and the number of intervening items in paired-associate tasks, he illustrated how slower processing speeds inhibit old age group' ability to establish stable internal representations of information. This reinforces the notion that processing speed is a critical factor in age-related declines in memory performance (Brown et al., 2012).

The reading span task, developed by Daneman and Carpenter in 1980, further informs our understanding of how working memory interacts with cognitive aging. This task challenges participants to remember the last word of a series of unrelated sentences while simultaneously processing and understanding the content. Research by Unsworth et al. (2009) indicated that old age group face greater difficulties than younger individuals in tasks like the reading span, highlighting the challenges posed by multitasking in cognitive frameworks. Across multiple studies, it became evident that as individuals age, the ability to manage the complex interplay between processing and storage noticeably declines, underscoring its importance for effective working memory function. Bopp and Verhaeghen (2005) conducted a meta-analysis that demonstrated old age group significantly underperform in complex span tasks compared to their younger counterparts. They suggested that this decline reflects deeper changes in cognitive resource management rather than simply slower retrieval. Their findings imply that older individuals struggle to maintain information in their working memory while effectively processing new incoming information. Borella, Carretti, and De Beni (2008) corroborated these findings by examining age-related changes in working memory. They discovered that old age group not only exhibit lower recall accuracy but also demonstrate slower processing times. Their results indicated that inefficiencies in processing could negatively affect information storage, leading to increased difficulties in tasks that require simultaneous processing and storage. Verhaeghen and Salthouse (1997) also supported the idea that aging impacts the ability to perform optimally on complex processing tasks, suggesting that old age group' reduced capacity for simultaneous processing and retention could reflect broader cognitive declines related to efficiency and speed, rather than just a straightforward deterioration of memory capacity.

Further expanding this framework, Blair et al. (2011) studied the role of inhibitory processes as contributors to working memory decline. Their findings revealed that old age group often exhibit impaired inhibitory efficiency, which compounds age-related challenges in memory recall and processing accuracy. This emphasizes the growing significance of inhibition in maintaining working memory performance as individuals age. Filtering out irrelevant information becomes increasingly essential, suggesting that addressing inhibitory efficiency may be just as important as focusing on processing speed.

Oberauer et al. (2003) offered a contrasting view by assessing storage and selective access within working memory. Their research indicated that old age group do not exhibit significant deficits in accessing information for computation under minimal cognitive load; their accuracy and processing times were comparable to younger individuals. However, when the cognitive demands increased, old age group experienced greater challenges than their younger peers, highlighting a crucial nuance: while selective access may remain intact, old age group struggle to maintain relevant information in working memory under heavier cognitive loads. Klencklen et al. (2017) strengthening this view investigated the impacts of age on real-world memory tasks, reinforcing the notion that cognitive aging results in declines in working memory performance across various memory loads. They found that the challenges old age group encounter are more directly related to increased memory demands and the complexities of real-world tasks rather than merely the types of information being remembered.

Taken together, these studies explain that working memory is characterized by a multifaceted decline across several dimensions, including processing speed, inhibitory efficiency, capacity for maintenance, and sensitivity to memory load. This broader perspective highlights that decline in working memory capacity with increasing age is not simply a matter of information loss; rather, it is intricately linked to how information is encoded, managed, and retrieved amid escalating cognitive demands. Collectively, this body of research emphasizes the complexity of working memory performance in old age group, revealing its dependence on a combination of cognitive resources and demands, rather than solely on raw memory capacity.

Cognitive Flexibility as a Component of Executive Function in Cognitive Aging

Cognitive flexibility is a crucial aspect of executive function that encompasses the ability to adapt one's thinking and behavior in response to changing circumstances and new information. As individuals age, cognitive flexibility becomes increasingly important for navigating daily challenges and maintaining overall cognitive health. This adaptability allows old age group to shift their attention between tasks, adjust strategies when faced with obstacles, and consider multiple perspectives in decision-making.

Cognitive flexibility encompasses the ability to shift attention between tasks, strategies, or mental sets, facilitating adaptable behavior and efficient goal-oriented actions. This adaptability is crucial for elderly individuals, enabling them to navigate the complexities of daily life as contextual demands shift. Research into cognitive flexibility often employs task-switching paradigms, which require individuals to alternate between multiple tasks rapidly. This process necessitates continual reconfiguration of cognitive operations and strategies (Allport & Wylie, 2000; Davidson et al., 2006; Monsell, 2003). Studies utilizing the

Wisconsin Card Sorting Task have showed age-related differences in cognitive flexibility, demonstrating that old age group tend to make more errors and exhibit reduced completion of categories compared to younger individuals (Axelrod & Henry, 1992; Daigneault, Braun, & Whitaker, 1992). Such findings explain the challenges old age group face in maintaining cognitive agility. Theoretical frameworks addressing cognitive aging often distinguish between executive control processes, such as task-switching and inhibitory control, and tasks with minimal executive demands. These process-specific theories posit that age-related deficits are concentrated in certain executive processes, including the ability to switch tasks effectively (Mayr et al., 2001).

A study by Kray and Lindenberger (2000) looked at how people of different ages switch between tasks. They tested 118 adults aged 20 to 80 and compared two types of task blocks: homogeneous (like AAAA...) and heterogeneous (like AABBAABB...). They measured general switch costs (the difference in speed between the two block types) and specific switch costs (the difference in speed between switching and not switching within heterogeneous blocks). The results showed that both switch costs were similar across different types of tasks (like word, shape, and number tasks) and were linked more to fluid intelligence than to general knowledge. Importantly, old age group had much higher general switch costs, indicating that their ability to manage switching tasks in working memory was more affected by age than their actual task performance.

The meta-analysis conducted by Verhaeghen and Cerella in 2002 investigated how aging impacts selective and divided attention. Selective attention refers to the ability to focus on one particular task or stimulus while ignoring others, while divided attention involves managing multiple tasks or stimuli at the same time. In their study, the researchers analyzed various tasks, including the Stroop test, which measures selective attention by testing how well participants can name colors when the words describing different colours are written in mismatched colors. They also looked at dual-task scenarios, where participants had to perform two tasks simultaneously, to assess divided attention. The analysis aimed to identify whether age-related differences exist in these attentional processes. The researchers found that old age group did not show significant deficits in selective attention, indicating that their ability to focus on a single task was relatively intact. However, they did observe notable challenges in dual-task performance and global task-switching, which involves quickly switching between different tasks or sets of information. Interestingly, the study revealed that both younger and old age group experienced similar levels of difficulties with dual-task performance, regardless of the complexity of the tasks. Additionally, the researchers noted that trying to apply executive strategies to improve performance in these scenarios didn't significantly help with simpler tasks, instead, it added more complexity. This suggests that old age group may find it challenging to manage multiple tasks not because of basic attention problems, but due to the increased complexity of the tasks they are dealing with. The study challenges the idea that age-related issues are mainly caused by specific executive deficits and suggests that performance differences in old age group are more about how complex the tasks are and the demands on their working memory.

Overall, cognitive flexibility which is the ability to switch and manage multiple tasks is of immense importance as people age. While old age group may have a harder time with task-switching, the findings indicate that these challenges are tied more to task complexity than to problems with attention itself. Understanding these nuances can help in creating targeted strategies to support the cognitive health in aging population.

Attention Inhibition as a Component of Executive Function in Cognitive Aging

The ability to suppress dominant, automatic, or habitual responses, when necessary, known as inhibitory control or response inhibition, is a cognitive process (Das & Misra, 2016; Diamond, 2013). This process allows individuals to inhibit their impulses and restrain natural, habitual, or dominant behavioral responses to stimuli, specifically pre-potent responses. Inhibitory control is crucial for selecting a more appropriate behavior that aligns with achieving one's goals (Das Naglieri & Kirby, 1994). It is considered to be an executive function, and task such as the Stroop Test (MacLeod, 1991; Friedman & Miyaki, 2017) is often used as exemplary measures of inhibition control and self-control.

Hasher and Zacks (1988) proposed that inhibition, as a cognitive mechanism, could explain various age-related changes in cognition. Specifically, they hypothesized that compromised inhibition in old age group would result in task-irrelevant information entering working memory, thereby reducing resources available for processing task-relevant information. This hypothesis spurred numerous studies investigating inhibitory deficits to elucidate the selective attention performance of old age group. Despite the complexity of the relationship between aging, inhibition, and cognitive function, as indicated by research reviews (McDowd, 1997; Hasher et al., 1999), inhibition has proven to be a valuable explanatory construct for understanding cognitive aging.

Compelling evidence supporting the decline in the ability to inhibit the processing of irrelevant information in aging adults comes from studies using the classic Stroop task. In this task, participants are presented with colour words written in different colours and must inhibit reading the word, focusing only on reporting the colour. When comparing performance between younger and old age group, older participants exhibit a more pronounced tendency for Stroop interference, i.e., incorrectly reporting the word instead of the colour. This suggests a compromised ability to inhibit incorrect responses in old age group (Hartley, 1993; Spieler, Balota & Faust, 1996).

A similar study was conducted by Troyer et al. (2006) using the Victoria Stroop Test (VST) to explore the association between age and response inhibition. The study aimed to resolve the debate over whether increased interference on Stroop tasks in aging is attributable to difficulties in response inhibition or generalized cognitive slowing. Administering the VST to 272 healthy adults aged 18 to 94, the results showed a negative correlation between age and speed across all VST trials, indicating that old age group generally took longer to respond than younger adults. However, the researchers took an important step to adjust for baseline cognitive slowing by factoring in the overall speed of responses independent of the task's interference component. After this adjustment, the analysis demonstrated that the correlation between age and interference scores remained significant. This finding suggests that while cognitive processing speed does decline with age, there is also a distinct and significant impact of aging on a person's ability to inhibit responses to competing stimuli. In other words, old age group not only respond more slowly but also face genuine challenges when it comes to filtering distractions and inhibiting automatic reactions, which is crucial in tasks like the Stroop Test. Notably, interference scores, adjusted for baseline slowing, correlated highly with age. It suggests that age-related interference is not entirely due to cognitive slowing. Furthermore, the scores of age and error on the interference trial were positively correlated, indicating reduced accuracy with age. The results imply that age-related interference on Stroop tasks likely reflects various cognitive changes, including decreased response inhibition.

These findings suggest that it is challenging to independently attribute age-related changes to speed or accuracy due to their interdependence on the stroop task. Regardless, the significant interference effect indicates challenges in areas such as decreased disengagement from the dominant reading response, increased impulsivity, and potential failures to maintain the task goal of ignoring the word dimension (Kane & Engle, 2003).

In a study where Milham et al. (2002) conducted an fMRI analysis to understand how old age group manage distractions while performing the Stroop task. They found that older participants experienced greater difficulty in ignoring irrelevant information, suggesting that their ability to filter out distractions may decline with age. The study also showed decreased activity in certain brain regions, particularly the dorsolateral prefrontal cortex (DLPFC) and the parietal cortex, which are essential for attentional control and working memory. These areas help us focus on relevant information while suppressing distractions. Specifically, the DLPFC is responsible for inhibiting semantic and phonological associations, as well as potential actions related to irrelevant information (Banich et al., 2015). These findings indicate that old age group may face more challenges in managing their attention and processing important information effectively.

The relationship between attention inhibition and cognitive aging is complex. It is characterized by the interaction of slowed response times and increased error rates. As individuals age, their capacity to disengage from dominant responses and manage impulsivity diminishes. This decline in inhibitory control, evidenced by studies indicate a broader set of cognitive changes impacting old age group, from reduced task accuracy to increased challenges in maintaining focus on task goals. Understanding these dynamics is vital, as they contribute to age-related cognitive decline. By recognizing the significance of inhibitory control within the framework of executive function along with its neurological underpinnings, we can better appreciate the challenges faced by old age group in managing their attention and cognitive resources.

CONCLUSION

In summary, the existing body of research highlights the intricate relationship between planning, executive function, and cognitive aging. While executive processes such as working memory, cognitive flexibility, and inhibitory control are vital for effective planning and daily functioning, these abilities tend to decline with age, leading to notable challenges for older adults. Differences in planning performance across age groups are influenced by both the complexity of tasks and the specific executive function demands required. Understanding these nuances not only deepens our comprehension of cognitive aging but also underscores the importance of developing targeted interventions and supportive environments to help older adults maintain independence and quality of life. Future research should continue to explore strategies that bolster executive function, ultimately promoting successful aging and adaptive problem-solving in later adulthood.

REFERENCES

Aarts, H., Dijksterhuis, A., & Midden, C. (1999). To plan or not to plan? Goal achievement or interrupting the performance of mundane behaviors. *European Journal of Social Psychology*, *29*(8), 971–979. https://doi.org/10.1002/(sici)1099-0992(199912)29:8%3C971::aid-ejsp963%3E3.0.co;2-a

Allain, P., Nicoleau, S., Pinon, K., Etcharry-Bouyx, F., Barré, J., Berrut, G., Dubas, F., & Gall, D. L. (2005). Executive functioning in normal aging: A study of action planning using the Zoo Map Test. *Brain and Cognition*, *57*(1), 4–7. https://doi.org/10.1016/j.bandc.2004.08.011

Allport, A., & Wylie, G. (2000). Task switching, stimulus-response bindings, and negative priming. *Attention and Performance*, *18*, 33–70. https://www.researchgate.net/publication/287697327_Task_switching_stimulus-response_bindings_and_negative_priming

Axelrod, B. N., Woodard, J. L., & Henry, R. R. (1992). Analysis of an abbreviated form of the Wisconsin card sorting test. *Clinical Neuropsychologist*, *6*(1), 27–31. https://doi.org/10.1080/13854049208404114

Baddeley, A. D., & Hitch, G. (1974). Working Memory. *Psychology of Learning and Motivation*, *8*(8), 47–89. https://doi.org/10.1016/S0079-7421(08)60452-1

Banich, M. T., & Depue, B. E. (2015). Recent advances in understanding neural systems that support inhibitory control. *Current Opinion in Behavioral Sciences*, *1*, 17–22. https://doi.org/10.1016/j.cobeha.2014.07.006

Blair, M., Vadaga, K. K., Shuchat, J., & Li, K. Z. H. (2011). The role of age and inhibitory efficiency in working memory processing and storage components. *Quarterly Journal of Experimental Psychology*, *64*(6), 1157–1172. https://doi.org/10.1080/17470218.2010.540670

Bopp, K. L., & Verhaeghen, P. (2005). Aging and Verbal Memory Span: A Meta-Analysis. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *60*(5), P223–P233. https://doi.org/10.1093/geronb/60.5.p223

Borella, E., Carretti, B., & De Beni, R. (2008). Working memory and inhibition across the adult life-span. *Acta Psychologica*, *128*(1), 33–44. Brennan, M., Welsh, M. C., & Fisher, C. B. (1997). Aging and Executive Function Skills: An Examination of a Community-Dwelling Old age Population. *Perceptual and Motor Skills*, *84*(3_suppl), 1187–1197. https://doi.org/10.2466/pms.1997.84.3c.1187

Brown, L. A., Brockmole, J. R., Gow, A. J., & Deary, I. J. (2012). Processing Speed and Visuospatial Executive Function Predict Visual Working Memory Ability in Old age group. *Experimental Aging Research*, *38*(1), 1–19. https://doi.org/10.1080/0361073x.2012.636722

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior*, *19*(4), 450–466. https://doi.org/10.1016/s0022-5371(80)90312-6

Das, J. P., Naglieri, J. A., & Kirby, J. R. (1994). *Assessment of Cognitive Processes*. Boston, MA: Allyn & Bacon.

Das, J. P., & Georgiou, G. K. (2016). Levels of planning predict different reading comprehension outcomes. *Learning and Individual Differences*, *48*, 24–28. https://doi.org/10.1016/j.lindif.2016.04.004

Das, & Misra, S. B. (2016). *Cognitive Planning and Executive Functions*. New Delhi, India

Davidson, M. C., Amso, D., Anderson, L. C., & Diamond, A. (2006). Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition, and task switching. *Neuropsychologia*, *44*(11), 2037–2078. https://doi.org/10.1016/j.neuropsychologia.2006.02.006

Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, *64*(1), 135–168. https://doi.org/10.1146/annurev-psych-113011-143750

Friedman, N. P., & Miyake, A. (2017). Unity and diversity of executive functions: Individual differences as a window on cognitive structure. *Cortex*, *86*(1), 186–204. https://doi.org/10.1016/j.cortex.2016.04.023

Grafman, J. (1989). *Plans, Actions, and Mental Sets: Managerial Knowledge Units in the Frontal Lobes*. 93–138. https://doi.org/10.4324/9780429489464-4

Guimond, A., Braun, C. M. J., Rouleau, I., Bélanger, F., & Godbout, L. (2006). Remembering the Past and Foreseeing the Future while Dealing with the Present: A Comparison of Young Adult and Elderly Cohorts on a Multitask Simulation of Occupational

Activities. *Experimental Aging Research*, *32*(3), 363–380. https://doi.org/10.1080/03610730600699100

Hartley, A. A. (1993). Evidence for the selective preservation of spatial selective attention in old age. *Psychology and Aging*, *8*(3), 371–379. https://doi.org/10.1037//0882-7974.8.3.371

Hasher, L., Zacks, R. T., & May, C. P. (1999). Inhibitory Control, Circadian Arousal, and Age. *Direct.mit.edu*. https://doi.org/10.7551/mitpress/1480.003.0032

Kane, M. J., & Engle, R. W. (2003). Working-memory capacity and the control of attention: The contributions of goal neglect, response competition, and task set to Stroop interference. *Journal of Experimental Psychology: General, 132*(1), 47-70. https://doi.org/10.1037/0096-3445.132.1.47

Klencklen, G., Banta Lavenex, P., Brandner, C., & Lavenex, P. (2017). Working memory decline in normal aging: Memory load and representational demands affect performance. *Learning and Motivation*, *60*, 10–22. https://doi.org/10.1016/j.lmot.2017.09.002

Lezak, M. D. (1983). *Neuropsychological assessment* (2nd ed.). New York: Oxford University Press.

Lindenberger, U., & Baltes, P. B. (1994). Sensory functioning and cognitive aging: Towards a unifying model. *Experimental Aging Research, 20(1),* 1-24. doi:10.1080/03610739408253983

Luria, A.R. (1966a). *Higher cortical functions in man.* Basic Books.

Luria, A. R. (1973). *The Working brain: An introduction to neuropsychology*. New York: Basic.

MacLeod, C. M., & Dunbar, K. (1988). Training and Stroop-like interference: evidence for a continuum of automaticity. *Journal of Experimental Psychology. Learning, Memory, and Cognition*, *14*(1), 126–135. https://doi.org/10.1037//0278-7393.14.1.126

Mayr U, Spieler DH, Kliegl R. (2201). *Aging and executive control.* New York: Routledge.

McDowd, J. M. (1997). Inhibition in Attention and Aging. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *52B*(6), P265–P273. https://doi.org/10.1093/geronb/52b.6.p265Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The Unity and Diversity of Executive Functions and Their Contributions to Complex "Frontal Lobe" Tasks: A Latent Variable Analysis. *Cognitive Psychology*, *41*(1), 49–100. https://doi.org/10.1006/cogp.1999.0734

Milham, M. P., Erickson, K. I., Banich, M. T., Kramer, A. F., Webb, A., Wszalek, T., & Cohen, N. J. (2002). Attentional Control in the Aging Brain: Insights from an fMRI Study of the Stroop Task. *Brain and Cognition*, *49*(3), 277–296. https://doi.org/10.1006/brcg.2001.1501

Monsell, S. (1996). Control of mental processes. In V. Bruce (Ed.), *Unsolved mysteries of the mind: Tutorial essays in cognition* (pp. 93–148). Erlbaum (Uk) Taylor & Francis, Publ.Monsell S. (2003). Task switching. *Trends in cognitive sciences*, *7*(3), 134–140. https://doi.org/10.1016/s1364-6613(03)00028-7

Oberauer, K., Wendland, M., & Kliegl, R. (2003). Age differences in working memory— The roles of storage and selective access. *Memory & Cognition*, *31*(4), 563–569. https://doi.org/10.3758/bf03196097

Park, D. C., & Reuter-Lorenz, P. (2009). The Adaptive Brain: Aging and Neurocognitive Scaffolding. *Annual Review of Psychology*, *60*(1), 173–196. https://doi.org/10.1146/annurev.psych.59.103006.093656

Ridderinkhof, K. Richard., Span, M. M., & van der Molen, M. W. (2002). Perseverative Behavior and Adaptive Control in Old age group: Performance Monitoring, Rule Induction, and Set Shifting. *Brain and Cognition*, *49*(3), 382–401. https://doi.org/10.1006/brcg.2001.1506

Salthouse, T. A. (1991). Mediation of Adult Age Differences in Cognition by Reductions in Working Memory and Speed of Processing. *Psychological Science*, *2*(3), 179–183. https://doi.org/10.1111/j.1467-9280.1991.tb00127.x

Shallice, T. (1982). Specific impairments of planning. *Philosophical Transactions of the Royal Society of London. B, Biological Sciences*, *298*(1089), 199–209. https://doi.org/10.1098/rstb.1982.0082

S Salthouse, T. A. (1994). The aging of working memory. *Neuropsychology*, *8*(4), 535–543. https://doi.org/10.1037/0894-4105.8.4.535

Shallice, T., & Burgess, P. W. (1991). Deficits in strategy application following frontal lobe damage in man. *Brain*, *114*(2), 727–741. https://doi.org/10.1093/brain/114.2.727

Spieler, D. H., Balota, D. A., & Faust, M. E. (1996). Stroop performance in healthy younger and old age group and in individuals with dementia of the Alzheimer's type. *Journal of Experimental Psychology: Human Perception and Performance*, *22*(2), 461–479. https://doi.org/10.1037/0096-1523.22.2.461

Stuss, D. T., Floden, D., Alexander, M. P., Levine, B., & Katz, D. (2001). Stroop performance in focal lesion patients: dissociation of processes and frontal lobe lesion location. *Neuropsychologia*, *39*(8), 771–786. https://doi.org/10.1016/s0028-3932(01)00013-6

Troyer, A. K., Leach, L., & Strauss, E. (2006). Aging and Response Inhibition: Normative Data for the Victoria Stroop Test. *Aging, Neuropsychology, and Cognition*, *13*(1), 20–35. https://doi.org/10.1080/138255890968187

Unsworth, N., Redick, T. S., Heitz, R. P., Broadway, J. M., & Engle, R. W. (2009). Complex working memory span tasks and higher-order cognition: A latent-variable analysis of the relationship between processing and storage. *Memory*, *17*(6), 635–654. https://doi.org/10.1080/09658210902998047

Verhaeghen, P., & Cerella, J. (2002). Aging, executive control, and attention: a review of meta-analyses. *Neuroscience & Biobehavioral Reviews*, *26*(7), 849–857. https://doi.org/10.1016/s0149-7634(02)00071-4

Verhaeghen, P., & Salthouse, T. A. (1997). Meta-analyses of age–cognition relations in adulthood: Estimates of linear and nonlinear age effects and structural models. *Psychological Bulletin*, *122*(3), 231–249. https://doi.org/10.1037/0033-2909.122.3.231

Zelinski, E. M., Dalton, S., & Hindin, S. (2011). Cognitive changes in healthy older adults. *Generations*, *35*(2), 13–20.

Acknowledgment

The author(s) appreciates all those who participated in the study and helped to facilitate the research process.

Conflict of Interest

The author(s) declared no conflict of interest.

How to cite this article: Das, G. (2026). Plan-Ex and Cognitive Aging: A Review of Executive Processes in Later Adulthood. *International Journal of Indian Psychology*, *14*(2), 1511-1524. DIP:18.01.141.20261402, DOI:10.25215/1402.141