Advances in functional brain imaging during the last two decades have opened new ways for studying these issues. The four talks in this symposium provide a review of this area of research, and are based on data collected with a variety of methods (ERPs, structural and functional MRI, and optical imaging) and within a number of experimental paradigms. Claude Alain will present ERP data suggesting that older adults may have impairments in the automatic detection of changes in an auditory stream. Bart Rypma and Art Kramer and collaborators will present fMRI data indicating a reprogramming of frontal lobe activity related to attention and working memory function, and Monica Fabiani and Gabriele Gratton will present ERP and optical data suggesting that inhibitory processes in the frontal lobes may be particularly affected by aging. Individual differences, compensatory mechanisms, interactions between brain areas and plasticity and recovery of function will be discussed.

**Symposium 12**

**Attention and Working Memory Changes in Aging**

Chair: Monica Fabiani
Presenters: Claude Alain, Bart Rypma, Arthur F. Kramer, Stanley J. Colcombe, Kirk Erickson, Paige Scalf, Edward McAuley, Monica Fabiani, Gabriele Gratton

Much recent evidence emphasizes that changes in attention control and working memory processes play a significant role in age-related cognitive decline. Advances in functional brain imaging during the last two decades have opened new ways for studying these issues. The four talks in this symposium provide a review of this area of research, and are based on data collected with a variety of methods (ERPs, structural and functional MRI, and optical imaging) and within a number of experimental paradigms. Claude Alain will present ERP data suggesting that older adults may have impairments in the automatic detection of changes in an auditory stream. Bart Rypma and Art Kramer and collaborators will present fMRI data indicating a reprogramming of frontal lobe activity related to attention and working memory function, and Monica Fabiani and Gabriele Gratton will present ERP and optical data suggesting that inhibitory processes in the frontal lobes may be particularly affected by aging. Individual differences, compensatory mechanisms, interactions between brain areas and plasticity and recovery of function will be discussed.

**AGING: A SWITCH FROM AUTOMATIC TO CONTROLLED PROCESSING OF SOUNDS?**

Claude Alain
Rotman Research Institute at Baycrest Centre for Geriatric Care & Department of Psychology, University of Toronto

Age-related changes in the peripheral auditory system are, in large part, responsible for the difficulties that older adults experience in detecting, locating, and recognizing simple and complex sounds such as speech and music. Presumably, such losses in peripheral sensitivity result in impoverished and noisy signals being delivered to the central nervous system, illustrating an inefficiency of automatic (data-driven) processes. It has been suggested that when stimulus degradation or other factors result in an impoverished signal, performance can be improved by exerting top-down control (e.g., by focusing attention on the stimuli, by inhibiting irrelevant material, etc.). Hence, we might expect older adults to rely more heavily on controlled processing if they are subject to age-related declines in automatic processing. We investigated whether aging differentially affects our ability to automatically and voluntarily process auditory information using event-related brain potentials. Young, middle-aged and older adults matched behaviorally in an auditory discrimination task showed similar patterns of neural activity indexing the voluntary and conscious detection of deviant (i.e., target) stimuli whereas the mismatch negativity wave indexing automatic processing was significantly reduced in middle-aged and older adults. These results indicate that aging affects the ability to automatically register changes in a stream of homogeneous stimuli. However, this age-related decline in automatic detection can be compensated for by top-down controlled processes.

**ISOLATING THE NEURAL MECHANISMS OF AGE-RELATED CHANGES IN WORKING MEMORY**

Bart Rypma
Rutgers University

Working memory (WM), the process by which information is coded into memory, actively maintained, and subsequently retrieved, is critical to many cognitive functions that decline with advancing age. Distinct neural systems in prefrontal cortex (PFC) are known to mediate WM task components but which of these systems is most affected by aging is currently unknown. In this talk, I will present data from several event-related fMRI studies aimed at investigating age-related differences in PFC activity during separate WM task components (Encoding, Maintenance, Retrieval) with varying memory loads. In the first study, younger adults showed greater PFC activity than older adults only in dorsolateral PFC, only during memory retrieval. Faster young subjects showed less dorsolateral PFC activation during retrieval than slower young subjects whereas the opposite pattern was observed in older adults. In the second and third studies, we tested the reliability and generalizability of these findings by replicating them with different subjects and with different stimuli. Based on these data we propose a model of age-related changes in PFC function that may account for these and other age-related differences in human cognitive performance.

**COGNITIVE AND BRAIN PLASTICITY OF OLDER ADULTS**

Arthur F. Kramer, Stanley J. Colcombe, Kirk Erickson, Paige Scalf, & Edward McAuley
University of Illinois at Urbana-Champaign

Aging has been associated with a decline in the efficiency of a multitude of perceptual, cognitive and motor processes as well as selective regions of the brain that subserve these processes. However, individual differences in the rate of
change across the adult lifespan of cognitive processes such as selective and divided attention have also been noted. Age-related individual differences in attentional control will be examined from two different perspectives in the presentation. First, I will present the results of several event-related fMRI studies that examine the relationship of performance to patterns of brain activation in both young and older adult groups. Contrary to previous suggestions more activation does not always suggest better performance for older adults. Second I will discuss a program of research in our laboratory that has focused on enhancing the cognitive abilities, particularly in attentional control skills, of older adults. This research has focused on the efficacy of both fitness and cognitive training for the cognitive and brain function of older adults. The results of several cross-sectional and longitudinal studies will be discussed as a means to illustrate the cognitive and brain plasticity of healthy older adults.

CHANGES IN DYNAMIC FILTERING AND INHIBITORY MECHANISMS IN NORMAL AGING

Monica Fabiani & Gabriele Gratton
University of Illinois at Urbana-Champaign

Many accounts of age-related cognitive decline have emphasized the importance of decreasing efficiency in attention control and inhibitory processes, especially in the context of working memory and conflict tasks. The weakening of filtering and/or inhibitory mechanisms may be indexed by the presence of increased and/or more persistent brain responses when these activities are no longer required by the task at hand. Within this perspective, we will first review ERP data suggesting that older adults continue to process repeated and/or task-irrelevant stimuli that are typically filtered out by younger adults. An additional way of investigating age-related changes in filtering processes is by examining brain imaging data for the presence of “negative” responses or of significant negative cross-correlations between the activities of different brain areas. This approach can be investigated with optical imaging methods, which allow for a combination of spatial and temporal specificity with little cross-talk across brain areas. In the second part of this talk, we will review optical data indicating the occurrence of both types of phenomena in young, but not in older adults, in a conflict task. These data suggest that the weakening of filtering processes (perhaps compensatory) and the decrease in the coordination of brain activity in different areas may play a significant role in cognitive aging.