

Electrophysiological Response during Source Memory Decisions in Older and Younger Adults

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We recorded event-related potentials (ERPs) as individuals made source monitoring decisions in a paradigm in which the influence of item familiarity and goal relevance could be separately evaluated. Younger and older adults read a list of words and subsequently distinguished these words from foils in a running recognition test in which some foils were repeated after a lag of 6 items, creating familiar lures. Behaviorally, older and younger adults performed equally well in the recognition of study words and the rejection of singly presented foils. However, older adults were more likely to respond to the familiar lures as though they had come from the study list, thus producing the expected group difference in source-monitoring error. For younger adults the ERPs elicited by the targeted study words were maximal at posterior sites and significantly greater than those elicited by either familiar lures or foils. Older adults generated far less differentiated ERP waveforms but with a markedly greater amplitude at frontal sites. We interpret this frontal maximum in the context of poorer source monitoring as suggesting that older adults are more dependent on controlled processes to make discriminations that seem to occur much earlier and more automatically for younger adults.

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Remembering involves not only the ability to detect a recently seen item among a series of foils, but also the ability to discriminate information that is currently relevant from a barrage of information, both internally and externally generated, much of which is familiar to some degree. Researchers have attempted to duplicate at least some of the complexity of real-world remembering by relying more on source monitoring paradigms—the laboratory equivalent of the multiple sources of familiarity that we deal with day to day. It has become apparent that to understand memory and especially those changes in memory associated with age, we need to understand those processes that allow us to work with memory in the service of task demands (e.g., Johnson, Hashtroudi, & Lindsay, 1993; Moscovitch, 1994).

Source monitoring paradigms have proven to be particularly sensitive in detecting age-related change in memory function. Individuals are typically presented with words that have become familiar in different contexts. For example, some words may have been spoken in a male voice and others in a female voice (Senkfor & Van

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Petten, 1998) or some actions may have been initially performed and others imagined (Hashtroudi, Johnson, & Chrosniak, 1990). At test, participants are first asked whether they recognize an item as having been seen before (an old/new decision) and then asked to designate the source of the items identified as "old." Almost invariably, older adults are more likely than younger adults to confuse the source of the recognized events (e.g., Craik, Morris, Morris, & Loewen, 1990; Dywan & Jacoby, 1990; Dywan, Segalowitz, & Williamson, 1994; Hashtroudi, Johnson, & Chrosniak, 1989; Schacter, Osowiecki, Kaszniak, Kihlstrom, & Valdiserri, 1994).

Whereas there is little disagreement that older adults are more vulnerable than younger adults to source memory error, the reasons for this are not clear. One view is that older adults have more difficulty discriminating between sources of familiarity due to deficits in the encoding of information (Grady et al., 1995; Jurica & Shimamura, 1999) or in the initial binding of that information to other neural traces associated with a specific event (Chalfonte & Johnson, 1996). Another view is that discriminating between sources of familiarity is only partially dependent on the quality of the memory trace *per se* because such discrimination is heavily influenced by factors associated with the efficiency and organization of retrieval strategies (Dywan et al., 1994; Koriat, Ben-Zur, & Sheffer, 1988; Multhaup, 1995; Rubin, Van Petten, Glisty, & Newberg, 1999). Age-related changes in these processes are thought to reflect age-related changes to frontal lobe function (Craik et al., 1990; Moscovitch, 1994) and thus a decline in controlled relative to automatic response tendencies (e.g., Hay & Jacoby, 1999; Jacoby, 1999; Jennings & Jacoby, 1993, 1997). Bäckman et al. (1997) postulate that strategic search could be disrupted when automatically activated representations are not inhibited during recall attempts. This is consistent with the view that aging brings with it a decline in inhibitory control in general (Hasher & Zacks, 1988; Zacks & Hasher, 1994) or, more specifically, a reduction in the ability to inhibit response tendencies (Dywan & Murphy, 1996; van der Molen & Ridderinkhof, 1998). Thus, a number of mechanisms have been proposed to explain the age-related decline in the contextual specificity of remembered events.

A promising approach has been to collect event-related potentials (ERPs) while older and younger adults are engaged in memory tasks. By examining millisecond-by-millisecond changes in neural response that have been time-locked to the presentation of old and new stimuli, researchers have hoped to learn more about those processes that occur prior to the individual actually making a behavioral response. Of most interest has been a positive deflection in the ERP waveform that occurs between approximately 400 to 800 ms post stimulus onset and which becomes more positive when elicited by stimuli previously presented in the experimental context. This deflection is referred to as the late positivity or late positive component (LPC) and has been thought by some to reflect familiarity (Johnson, Pfefferbaum, & Kopell, 1985; Rugg & Doyle, 1992) and by others to reflect an effortful recollective process (e.g., Paller & Kutas, 1992; Smith, 1993; Wilding & Rugg, 1996). However, interpreting these data in the context of age-related memory performance is not straightforward (Dywan, 2000; Friedman, 2000).

It has been shown that when memory is measured indirectly, i.e., when responding to previous occurrence is not the putative goal of a task, older adults produce late positivities of equal or greater amplitude than those produced by younger adults (Friedman, Berman, & Hamberger, 1993; Karayanidis, Andrews, Ward, & McConaghy, 1993). As well, a diagnosis of dementia does not seem to interfere with the ability to generate an ERP response to familiar items in an indirect test (Friedman, Hamberger, Stern, & Marder, 1992; Rugg, Pearl, Walker, Roberts, & Holdstock, 1994) suggesting that this response is based at least in part on automatic, stimulus-based response tendencies. More recently, direct and indirect memory tests have been

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