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Aging ebbs the flow of thought: Adult age differences in mind wandering, executive control, and self-evaluation

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ABSTRACT

Two experiments examined the relations among adult aging, mind wandering, and executive-task performance, following from surprising laboratory findings that older adults report fewer task-unrelated thoughts (TUTs) than do younger adults (e.g., Giambra, 1989; Jackson & Balota, 2012). Because older adults may experience more ability- and performance-related worry during cognitive tasks in the laboratory, and because these evaluative thoughts (known as task-related interference, "TRI") might be sometimes misclassified by subjects as task-related, we asked subjects to distinguish task-related thoughts from TRI and TUTs when probed during ongoing tasks. In Experiment 1, younger and older adults completed either a go/no-go or a vigilance version of a sustained attention to response task (SART). Older adults reported more TRI and fewer TUTs than did younger adults while also performing more accurately. In Experiment 2, subjects completed either a 1- or a 2-back version of the *n*-back task. Older adults again reported more TRI and fewer TUTs than younger adults in both versions, while performing better than younger adults in the 1-back and worse in the 2-back. Across experiments, older adults' reduced TUT rates were independent of performance relative to younger adults. And, although older adults consistently reported more TRI and less mind wandering than did younger adults, overall they reported more on-task thoughts. TRI cannot, therefore, account completely for prior reports of decreasing TUTs with aging. We discuss the implications of these results for various theoretical approaches to mind-wandering.

1. Introduction

Young adults spend, on average, a third to half of their daily lives thinking about something other than their current activity (Kane et al., 2007; Killingsworth & Gilbert, 2010; Klinger & Cox, 1987–1988; McVay, Kane, & Kwapil, 2009). Unfortunately, these task-unrelated thoughts (TUTs) can sometimes result in "absentminded" mistakes (e.g., McVay et al., 2009; Reason, 1990; Schooler, Reichle, & Halpern, 2004; Smallwood et al., 2004). Mind wandering is thus a frequent, yet occasionally costly, experience. It also occurs more frequently for some people than others: college students who have poorer cognitive-control abilities, such as those with lower working memory capacity (WMC; Kane et al., 2007; McVay & Kane, 2009, 2012a, 2012b) and attention deficit/hyperactivity disorder (AD/HD; McVay et al., 2008; Shaw & Giambra, 1993), report more TUTs during challenging tasks than do people with better control abilities.

1.1. Mind wandering and adult aging

As we age, then, does the propensity to mind-wander increase? Do TUTs account, in part, for older adults' performance deficits in many tasks involving cognitive control? Based on age-related decline in many domains, including WMC (see Craik & Salthouse, 2008), and on theoretical accounts that propose deficits in goal maintenance or attentional inhibition to explain age differences in executive control (e.g., Braver & West, 2008; Hasher & Zacks, 1988), we might expect that older adults are often mind wandering. For example, the Braver–West view claims that older adults have difficulty maintaining task-related goals to intentionally guide actions; an age-related inability to keep task-irrelevant information from becoming conscious (as TUTs) should thus disrupt active maintenance or accessibility of task goals, thereby leading to errors. Indeed, Hasher and Zacks originally theorized that such impaired inhibition is the root of much age-related variance in cognition (see Hasher, Lustig, & Zacks, 2007; Hasher, Zacks, & May, 1999).

Counter to this prediction, however, and in contrast to most WMC-related findings with younger adults (e.g., Kane et al., 2007; McVay & Kane, 2009; but see Levinson, Smallwood, & Davidson, 2012), older adults actually report *less* frequent TUTs than do younger adults (Giambra, 1989; Grodsky & Giambra, 1990–1991; Jackson & Balota, 2012; Krawietz, Tamplin, & Radvansky, in press). The negative correlation between age and mind-wandering rate was first established via retrospective questionnaires (e.g., Giambra, 1977–78; Singer & McCraven, 1961), and may have reflected age-related memory or metacognitive deficits, or a reporting bias. To demonstrate

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aging's effect on mind wandering in a controlled setting, Giambra (1989) measured TUTs during a laboratory vigilance task with instructions aimed to encourage reporting and to limit self-censure. Across five experiments, older adults reported fewer TUTs than did younger adults.

Giambra's (1989) findings are surprising from the perspective that aging impairs executive control and that executive-control failures predict TUTs. Indeed, Giambra discussed these results as contradicting the Hasher and Zacks (1988) view that older adults have decreased inhibitory ability. Giambra argued, instead, that TUTs represent trains of thoughts, or "unfinished business," which come to a conclusion during unconscious processing and then require attentional capacity to enter awareness. In other words, when performing a task that does not require full attention, excess attentional capacity can be devoted to mind wandering. Accordingly, younger adults should experience more TUTs than should older adults because they have more attentional capacity and more often an excess to allow TUTs. Giambra further explained, however, that his tasks were designed to allow plenty of attentional capacity to spare (supported by ceiling-level performance), and proposed that older adults have less "unfinished business" than do younger adults, leading to fewer and less urgent unconscious thoughts.

1.2. Executive processes in mind wandering

Giambra (1989) thus foreshadowed a current debate about the role of executive resources in TUTs. The Smallwood and Schooler (2006) theory of mind wandering characterizes TUTs as requiring the resources typically used for executive control (see also Teasdale et al., 1995), with evidence drawn from studies showing that: (1) tasks imposing greater cognitive loads reduce TUT rates (e.g., Antrobus, 1968; Teasdale, Lloyd, Proctor, & Baddeley, 1993; Teasdale et al., 1995) and, conversely, practice-driven automaticity increases TUT rates (e.g., Mason et al., 2007; Teasdale et al., 1995); (2) executive-control brain networks, along with "default mode" networks, are active during mind wandering (e.g., Christoff, Gordon, Smallwood, Smith, & Schooler, 2009); (3) in-the-moment TUT reports predict performance errors, suggesting competition for a unitary processing capacity (e.g., Smallwood et al., 2004); (4) individual differences in control capabilities may be *positively* associated with TUT rates during very simple tasks, such as breath monitoring, indicating that people with more available resources use them to mind-wander (Levinson et al., 2012, but see McVay & Kane, 2012a, 2012b).

McVay and Kane (2010a), in contrast, propose a "control failures × current concerns" view that takes the opposite stance on the role of executive capacity: the contents of TUTs are automatically and continuously generated unconsciously in response to environmental cues to subjects' current concerns and goals (following Klinger, 1971, 1999, 2009), similar to Giambra's concept of "unfinished business." Cued TUTs then enter awareness as a result of an executive-control failure, as opposed to the availability of excess capacity. Their main sources of evidence were: (1) TUTs predict performance deficits on attention-demanding tasks (e.g., McVay & Kane, 2009; McVay et al., 2009; Smallwood et al., 2004), which may indicate that TUTs enter awareness when control falters, rather than when there is capacity to spare; (2) contexts that impair control abilities, such as fatigue (e.g., Antrobus, Singer, & Greenberg, 1966; McVay & Kane, 2009; Smallwood et al., 2004; Smallwood, Heim, Riby, & Davies, 2005; Teasdale et al., 1995) and inebriation (Finnigan, Schulze, & Smallwood, 2007; Sayette, Reichle, & Schooler, 2009), increase TUTs; (3) individual differences in control are *negatively* associated with TUT rates during demanding tasks (e.g., McVay & Kane, 2009, 2012a, 2012b; Shaw & Giambra, 1993); (4) subjects who have greater attention control suffer as much performance cost as those with poorer control on occasions when they experience TUTs, in conflict with a resource-availability view that predicts spare resources to minimize dual-tasking costs.[1]

Giambra's (1989) findings of TUTs decreasing with age seem to fit more comfortably with the executive-resource view of mind wandering than the control failures × concerns view. Older adults, who have reduced WMC (Bopp & Verhaeghen, 2005) and poorer attention control (e.g., Cohn, Dustman, & Bradford, 1984; Hamm & Hasher, 1992; Hartley, 1993; Spieler, Balota, & Faust, 1996; West & Baylis, 1998), should experience more control failures than should younger adults. If control failures drive mind-wandering, then older adults should mind-wander more frequently. Thus, older adults' reduced rate of mind-wandering seems to suggest, instead, that they have insufficient resources to maintain TUTs in the face of simultaneous tasks. Given the potential importance of aging findings to general theories of mind-wandering, we thought it necessary to confirm and expand on Giambra's results. In the current study, we improve upon Giambra's methods and address an alternative explanation for the age-related differences in TUTs he found.

1.3. Age differences in mind-wandering: methodological and theoretical considerations

Although Giambra's (1989) laboratory studies improved upon retrospective surveys of mind-wandering tendencies, he asked subjects whether they had experienced any TUTs during 25–30 s task periods, a long enough delay to allow forgetting or confabulation. In our studies, as is now common (Smallwood & Schooler, 2006), we further reduced retrospective biases by probing subjects randomly throughout the task and having them report on their *immediately* preceding thoughts. In addition, Giambra's vigilance tasks yielded ceiling performance, which prevented assessment of TUT–performance associations (which bears on whether TUTs draw on executive resources). The current studies kept performance below ceiling to allow tests of whether in-the-moment costs of TUTs were similar across age groups.

While we were conducting the current studies, both Jackson and Balota (2012) and Krawietz et al. (in press) similarly reported age-related decreases in TUTs. Moreover, they did so using random, in-the-moment thought probes (like ours) during variations of a go/no-go task (the "sustained attention to response task" [SART]; Jackson & Balota, 2012) or reading comprehension tasks (Jackson & Balota, 2012; Krawietz et al., in press). Although Jackson and Balota did not assess age differences in the consequences of TUTs for performance, Krawietz et al. reported that both older and younger adults were similarly inaccurate in answering reading comprehension questions following TUT reports versus on-task-thought reports; moreover, Krawietz et al. found age differences in TUT rates within tasks that yielded either no age differences in accuracy (Experiment 1) or significant age differences in accuracy favoring younger adults (Experiment 2). A growing body of data thus points consistently to reduced TUT rates in older versus younger adults, regardless of age differences in corresponding task performance.

[1] According to a view that mind-wandering episodes draw on general executive resources and that tasks that require more resources allow for less mind wandering, McVay and Kane (2012a, 2012b) argued that it should also follow that the performance of people with more resources available should be less affected by mind-wandering than should that of people with fewer resources available. Someone with more resources should be able to dedicate more of them to two simultaneous activities (task performance and maintaining TUTs) than should someone with fewer resources (e.g., Norman & Bobrow, 1975; Posner & Boies, 1971). However, we acknowledge that resource theories are generally flexible enough – indeed, often to the point of unfalsifiability – to allow for multiple, if not contradictory, predictions (see Navon, 1984). For example, one might claim that ongoing task performance should be hurt equally for people with more and with fewer resources because those with more resources will engage in more complex, resource-intensive TUTs than might those with fewer resources.