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Cognitive Interventions and Aging

Improving Cognitive Function in Older Adults: Nontraditional Approaches

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This article considers two nontraditional approaches for developing interventions to improve cognition in older adults. Neither of these approaches relies on traditional explicit training of specific abilities in the laboratory. The first technique involves the activation of automatic processes through the formation of implementation intentions that enhance the probability that a desired action will be completed, such as remembering to take medications. The second involves experimentally studying the role of active social and cognitive engagement in improving cognition. We then consider methodological issues associated with the use of these novel techniques.

FOR the past two decades, researchers have carefully documented the decline in basic cognitive processes that occurs with age, as well as the stability or growth of knowledge. As a result of this work we have an excellent understanding of age-related changes in basic processes such as sensory function, speed of processing, and working memory, as well as the interrelationships among these processes and how they predict higher order cognitive function (Baltes & Lindenberger, 1997; Park et al., 2002; Salthouse, 1996). Moreover, recent advances have led to an understanding of the neural underpinnings of age-related differences in cognitive function. There is evidence that older adults show additional compensatory frontal recruitment compared to younger persons while performing both working memory and long-term memory tasks (Park & Gutchess, 2004; Park, Polk, Mikels, Taylor, & Marshuetz, 2001; Reuter-Lorenz, 2002; Reuter-Lorenz & Lustig, 2005), providing evidence for considerable flexibility and reorganization in neural circuitry with age.

As the field of cognitive aging matures, researchers are increasingly raising the question of how we can use our relatively sophisticated understanding of the mechanisms underlying cognitive aging to improve the functional status of older adults. One initial approach that seems like an obvious and logical approach is to train people in basic cognitive processes that become deficient with aging and are important for predicting higher order cognitive function. There are a number of training studies that have, for example, demonstrated improvement in speed of processing on specific tasks in an older adult sample (e.g., the Advanced Cognitive Training for Independent and Vital Elderly [ACTIVE] trial conducted by Ball et al., 2002). Speed is an important mediator of age-related variance in a broad range of cognitive processes (Park et al., 2002; Salthouse, 1996), so it has been quite disappointing that improving speed through training has not resulted in a global improvement in a range of cognitive processes—improvements have thus far been limited to only the trained ability (e.g., Ball et al., 2002). Researchers have by no means exhaustively studied this traditional approach to improving cognitive processing through training, and much interesting and important research remains to be done in this area. At the same time, it seems worthwhile to also explore nontraditional approaches to improving functionality in older adults. When we use the term *nontraditional* in this context, we are referring to studies that do not attempt to train explicitly specific cognitive mechanisms such as speed, working memory, or long-term memory through practice. Rather, nontraditional approaches attempt to improve cognitive function through either exploiting intact cognitive processes with age or by using broad-based intervention techniques that provide general intellectual stimulation and result in a global increase in cognitive function. We present a discussion of examples of both of these approaches in this article, along with an evaluation of particular issues that experts need to address in the design and interpretation of such studies.

The focus on how to improve or simply maintain cognitive function in late adulthood is an important one because normal age-related cognitive decline, as well as Alzheimer's disease, may put individuals at risk for losing the ability to live independently. Everyday tasks like financial management or medication adherence have substantial cognitive components, and the inability to perform these tasks adequately may result in institutionalization, a move to a family member's home, or contracting for a live-in caregiver. Developing techniques or interventions that either enhance cognition or limit declines with age is of critical social importance, as these techniques will maintain the independence of older citizens and, in addition, minimize costs to both families and governments that result from increased caregiving needs associated with cognitive frailty.

Despite the fact that many studies that have attempted to develop lasting improvements in cognitive function with age have not been successful, we continue to believe that important work remains to be done in this area. We also believe that persistence at intervention research will ultimately yield promising outcomes and provide evidence that the application of certain techniques can slow cognitive decline or even improve cognition in affected older adults. Why do we believe that there are training or experimental conditions that can affect the trajectory of cognitive function with age? The simplest answer is to consider the many demonstrations of cognitive flexibility in both healthy and brain-damaged older adults. Research has shown that healthy older adults compensate for processing decline by relying on alternative strategies to perform tasks. For example, using structural equation models, Hedden, Lautenschlager, and Park (2005) demonstrated that whereas young adults relied almost exclusively on basic processing abilities like speed and working memory in a cued recall task, older adults utilized verbal knowledge to compensate for decreased speed and working memory abilities. There is also a wealth of evidence indicating that older adults show additional neural recruitment compared to young adults when performing cognitive tasks (e.g., Cabeza, Anderson, Locantore, & McIntosh, 2002; Gutchess et al., 2005; Reuter-Lorenz, 2002; Reuter-Lorenz & Lustig, 2005), suggesting augmentation from other structures or reorganization of neural circuitry with age. Moreover, aged stroke patients present an even stronger case for cognitive flexibility in late adulthood. Despite devastating brain injuries, even very old adults show dramatic improvement from strokes with enormous amounts of training and practice due to the residual plasticity and malleability of their brains (Hallett, 2001). In this article, we consider two nontraditional approaches to improving cognitive function in older adults. The first approach is relatively narrow and relies on exploiting automatic components of cognitive function that do not decline with age (Jacoby, 1999; Park, 2000). The second approach is exceptionally broad and focuses on the role of social, intellectual, and emotional engagement in increasing cognitive and neural function in older adults. We discuss each of these approaches in turn.

Improving Cognition Through Activation of Automatic Processes

One area that has received a great deal of attention in improving everyday function of older adults is the area of medical adherence. This is a particularly salient issue for older adults, given that the cognitive declines that accompany normal aging (see Park et al., 2002) may affect adherence by impeding older adults' ability to perform desirable health maintenance behaviors. A substantial literature on medical information processing indicates that older adults may have more difficulty comprehending, remembering, and following physician instructions compared to younger adults (Brown & Park, 2002; Halter, 1999; Morrell, Park, & Poon, 1989; Park, 1992; Park & Kidder, 1996; Park, Willis, Morrow, Diehl, & Gaines, 1994; Salzman, 1995). One approach to improving medication adherence has been to train the component processes thought to underlie medication adherence, such as speed of processing, reasoning, and memory. Ball and colleagues (2002) demonstrated that although training on component processes improved performance on those component processes, the improvement did not transfer to activities of daily living (e.g., medication adherence). Another major approach has not involved training, but rather has relied on the provision of external cues and reminders (Park, Morrell, Frieske, & Kincaid, 1992; see Park & Jones, 1996, for a review) or the reorganization of medical information to make it more memorable (Morrell, Park, & Poon, 1990; Morrow, Leirer, & Andrassy, 1996). These nontraining approaches have been relatively successful in facilitating adherence behavior.

Nevertheless, it is not always possible to rely on external cues or restructuring of information, and it would be very desirable to develop effective training or instructional techniques to foster improvement that rely on improving some aspect of cognitive function within the individual. One successful strategy for improving cognition in older adults might be to rely on cognitive processes that remain intact with age in the service of a particular goal, rather than attempting to train declining function.

One example of this strategy with respect to medical adherence would be to improve adherence to health behaviors in older adults by capitalizing on automatic processes that require little cognitive effort and remain intact with age (Jacoby, 1991; Jacoby, Jennings, & Hay, 1996; Jacoby, Yonelinas, & Jennings, 1997; Park, 1999, 2000). There is an intriguing social psychological literature that demonstrates that the act of imagining a detailed plan to perform a specific action actually increases the probability that one will implement the plan (Gollwitzer, 1999). Forming implementation intentions entails the explicit imagining and then rehearsal of how one will initiate a desired behavior when he or she encounters appropriate cues in the environment. Later, when the individual encounters these specific cues, he or she automatically cues the performance of the imagined behavior. Of particular interest is evidence that the behavioral strategy of forming detailed implementation intentions specifying how, where, and when in the future one will complete a desired behavior automatically enhances goal achievement without rehearsal or the engagement of effortful cognitive processes that are sensitive to age-related decline. For example, Gollwitzer and Brandstatter (1997) had college students agree to write a brief report of how they spent their Christmas Eve within 2 days of the event. Half of the participants developed an implementation intention involving the specific time and place they would complete the written report, whereas other participants simply agreed to write the report. Those who developed an implementation plan were much more likely to write the report in the specified time period than were those who were in the other condition. The ability of a relatively simple laboratory manipulation to initiate the performance of a complex real world behavior was quite surprising. Forming implementation intentions would appear to be a particularly effective strategy for improving older adults' prospective memory (remembering to perform future actions) because the strategy relies on age-invariant automatic processes rather than explicit recollection of information from memory, a controlled process that declines with age (Park, 2000; Park et al., 2002).

Evidence that implementation intentions can support prospective memory in older adults was initially reported for research done in the laboratory. Chasteen, Park, and Schwarz (2001) asked older adults at the beginning of an experiment to imagine writing the day of the week at the top of their paper just before they handed it in after finishing the experiment. Chasteen and colleagues found that, despite demonstrating significant differences in effortful free-recall performance compared to younger persons, older adults who imagined the implementation of writing the date on a response sheet at the end of a lengthy experiment were nearly twice as likely to perform this intended action as older adults who used alternative memory strategies, such as explicitly rehearsing the need to remember to perform the action. These data suggest that the use of implementation instructions is an effective strategy for improving cognition on a specific task in older adults.

In a later study, Liu and Park (2004) investigated whether the improvements in older adults' memory for completing a laboratory task would generalize to a complex behavior in a naturalistic setting. They studied the ability of older adults to remember to monitor their glucose at four predetermined times of day. Participants were to perform the task at the same time every day for 3 weeks. Each participant received training in using a glucose monitor (which required piercing a finger with a lancet and placing a few drops of blood on a strip, which a machine then read). The machine recorded the date and time, providing a detailed record of when the participant completed the intended actions. After instruction in the use of the glucose monitor, participants did one of three things. One group rehearsed the times they were to perform the glucose-monitoring task; the second group considered the pros and cons of performing the task; and the third group used implementation intentions, imagining exactly what they would be doing the next day while they performed the monitoring task (development of an implementation intention). The 5 minutes it took to imagine the glucose-monitoring task increased adherence to the task substantially, and participants sustained this increase for 3 weeks (see Figure 1). These findings provide convergent evidence that implementation intentions are effective in supporting some specific types of memory behaviors in older adults without requiring extensive training or reliance on effortful cognitive functions that normally decline with age.

The effect of implementation intentions on enhancing the completion of desired behaviors is robust and surprisingly large, given the simplicity and time involved in plan formation. In a meta-analysis of the impact of implementation intentions on goal completion, Gollwitzer and Sheeran (2006) examined 94 effects and reported evidence for a medium to large effect size for the effect of implementation intentions, despite the inclusion of some unpublished studies (such inclusion would act to decrease the effect size, given the proclivity to publish only significant results). They also examined effect sizes associated specifically with a range of different self-regulatory problems. Gollwitzer and Sheeran reported, for example, that the effect size of implementation instructions on "remembering to act" was 0.54 standard deviation units (although none of the samples included older adults), confirming the effect of implementation intentions on the cognitive component of goal completion. The meta-analysis also provided evidence that the implementation intentions led directly to enhanced saliency of imagined cues when they were later encountered, and also enhanced cue detection, discrimination, and accessibility, as well as attention and memory to the cue. These are profoundly important findings, as they provide strong evidence that the formation of implementation intentions is directly supportive of the cognitive aspects of goal completion, albeit in nonaged populations. We speculate that implementation intentions will be equally supportive of the cognitive components of goal completion in older adult populations, but thus far, the Chasteen and colleagues (2001) and Liu and Park (2004) studies are the only published data of which we are aware that used an older adult population.

Another finding from the implementation intention literature of particular importance for the elderly population was that

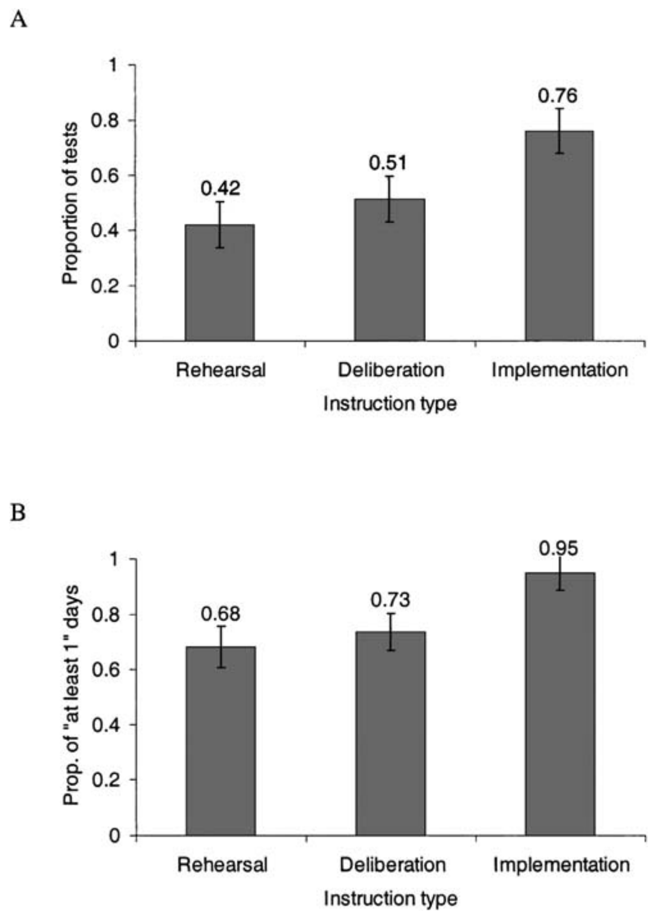

Figure 1. **(A)** Average proportion of blood glucose tests performed correctly as a function of instruction type received. **(B)** Average proportion of days in which participants performed at least one blood glucose test correctly as a function of instruction type received. Error bars represent ± 1 *SE* of the mean. Prop. = proportion. Figure reprinted with permission from Liu & Park (2004).

concurrent cognitive load did not affect the tendency to complete an action based on implementation intentions (Brandstatter, Lengfelder, & Gollwitzer, 2001). This suggests that the decreased cognitive capacity of older adults should not limit the impact of implementation intentions, although researchers need to investigate this. Despite the lack of data on older adults, the extant literature suggests that, for other populations that have been studied, implementation intentions are powerful in supporting memory and attention to cues associated with a planned behavior as well as in enhancing goal completion under a broad range of conditions. The fact that the two existing studies on aging and implementation intentions (Chasteen et al., 2001; Liu & Park, 2004) found robust effects of intention formation on goal completion suggests that other effects observed in young adults are likely to generalize to an older adult population.

Gollwitzer and Sheeran's (2006) meta-analysis also examined the impact of implementation instructions on noncognitive, motivational aspects of goal completion. Participants who formed intentions were better than participants who did not form such intentions at not missing good opportunities to act in circumstances when there was a time window and at not failing to act due to short-term considerations. Gollwitzer and Sheeran also found medium to large effect sizes for the impact of implementation intentions on shielding desired goals from negative influences and initiating goal striving. If individuals formulated "if-then" plans (e.g., "If I encounter a distracting influence, such as a phone call or television program, I will still remember to complete my goal"), these intentions were effective at shielding them from becoming derailed and even at suppressing a counterproductive behavioral response (e.g., eating cake instead of the planned vegetables). This is a particularly interesting finding with respect to older adults, who have problems suppressing attention to irrelevant information (Hasher & Zacks, 1988) and performance of irrelevant behaviors. It is also important to note that the meta-analysis yielded no evidence that individuals who formed implementation intentions were compelled to perform tasks rigidly, and that cues only initiated behaviors in the presence of goal intentions. This suggests that top-down internal processes ("I need to complete this goal") guided the bottom-up impact of environmental cues. It is possible, of course, that older adults may be controlled more by environmental cues and less by top-down controlled processes, so that they are more rigidly controlled by environmental cues than are young adults. This is an important potential direction for future study.

More research is needed to determine the impact of implementation intention formation on older compared to younger adults. There may be situations where the formation of intentions may be more productive for older adults, given their greater reliance on automatic processes; but, at the same time, controlled processing failures could result in the intentions being less effective or even disruptive for older adults. For example, research on false memory has demonstrated that imagining the occurrence of an event that did not happen inflates participants' later confidence that the event did happen. Research has shown that this effect, known as *imagination inflation* (e.g., Garry, Manning, Loftus, & Sherman, 1996; Goff & Roediger, 1998) is especially pronounced in older adults (Lyle, Bloise, & Johnson, 2006). This suggests that there could be circumstances in which forming an implementation intention to take a medication might lead to lower levels of adherence, because older adults could mistake the imagined pill-taking event as already having occurred and thus would not take the needed dose of medication.

In addition, individual differences could play a large role in determining who benefits from implementation instructions. For example, would the benefits of implementation intentions extend to memory-impaired elders? Evidence thus far suggests that action-impaired samples such as frontal lobe patients (Lengfelder & Gollwitzer, 2001) have benefited from implementation intentions, suggesting that these techniques may be particularly beneficial for older adults. It would also be very interesting to study the training of implementation intentions as a general strategy for facilitating performance. In other words, can older adults be trained to spontaneously employ implementation intentions to help performance on a variety of behaviors? At a more general level, the search for other manipulations that exploit intact automatic processes in older adults holds promise to ameliorate age-related decline on performance of both laboratory tasks and instrumental activities of daily living.

Improving Cognitive Function Through Engagement

A second nontraditional approach to cognitive interventions involves examining the effects of engagement in social and leisure activities on maintaining or enhancing cognitive function. With this approach, the idea is to examine whether sustained engagement in an interesting everyday activity somehow improves cognitive function. The first question one might ask about this approach is why researchers would even consider the possibility that engagement in leisure activities could somehow improve cognition. There is a surprisingly large correlational literature that suggests that older individuals who self-report greater engagement in a variety of leisure, cognitive, and physical activities show improvement on cognitive batteries relative to individuals who self-report less engagement (e.g., Christensen et al., 1996; Singh-Manoux, Richards, & Marmot, 2003). There are also data that suggest that individuals who engage in intellectually stimulating or highly social leisure activities are less likely to be diagnosed with Alzheimer's disease (e.g., Barnes, Mendes de Leon, Wilson, Bienias, & Evans, 2004; Crowe, Andel, Pedersen, Johansson, & Gatz, 2003; Schaie, 1984; Wilson et al., 2000). Scarmeas, Levy, Tang, Manly, and Stern (2001) followed older adults for 7 years and reported that engagement in leisure activities during those years was protective against Alzheimer's disease, even when initials level of health, education, and illness were controlled. A nearly identical finding was reported for a population-based study of older Swedes that was conducted over 6.5 years (Wang, Karp, Winblad, & Fratiglioni, 2002). A particularly provocative finding was that even social engagement alone exerts strong protective effects against Alzheimer's disease (Bassuk, Glass, & Berkman, 1999; Fratiglioni, Wang, Ericsson, Maytan, & Winblad, 2000). In a longitudinal study that included detailed measures of cognitive function, Hultsch, Hertzog, Small, and Dixon (1999) reported that older adults who reported higher levels of participation in intellectual activities showed higher levels of cognitive function relative to those who reported less engagement in intellectual activities. Other research demonstrated that individuals who engaged in substantively complex work across their life span showed greater cognitive flexibility than did those who performed less intellectually demanding jobs (Schooler, Mulatu, & Oates, 1999).

Although these findings are tantalizing, they are hardly definitive in addressing the role that engagement can play in facilitating cognition. There is always the possibility that individuals who are less engaged are suffering from incipient Alzheimer's disease, depression, or other conditions that might affect both their cognitive function and leisure activities, and that there is no actual relationship between the engaged behavior and better cognitive function. Despite these concerns, researchers need to recognize that "use or lose it" is an important and pervasive phrase that characterizes the way many people think about cognitive aging in our culture. This view actually fits very well with American values of self-reliance and the sense that personal effort is a critical determinant of health and other behavioral outcomes. There is also evidence that self-reliance itself, conceptualized as self-efficacy in the literature, can promote the recruitment of resources, thereby enhancing performance (Stine-Morrow, Shake, Miles, & Noh, 2006;

Welch & West, 1995). Given the pervasiveness of the "use it or lose it" view, the possible benefits of that view for healthy cognitive functioning, and the tantalizing nonexperimental data suggesting a relationship between engagement and cognitive function, it is actually quite surprising that there are so few experimental studies of the role of intellectual engagement on cognitive function in late adulthood.

Recently, Salthouse (2006) argued that there is no significant evidence that sustained intellectual engagement differentially impacts the rate of age-related cognitive decline. Although we have no disagreement with the data as presented by Salthouse (2006), we continue to believe that it is likely that careful studies will yield evidence for a positive impact of cognitive engagement on multiple measures of cognitive function across an array of domains for the following reasons. First, there are significant nonexperimental data on humans to suggest that the engagement hypothesis is plausible and meritorious of consideration and further experimental study. Besides the human data, there is also significant experimental work on animals that indicates that older rats in stimulating environments experience neurogenesis (i.e., the birth of new neurons; Jones, Klintsova, Kilman, Sirevaag, & Greenough, 1997; Kleim, Vij, Ballard, & Greenough, 1997). Second, there is no question that brain reorganization occurs in older adults who have suffered a stroke and who engage in sustained practice and training. New areas of the brain literally learn to control new functions, suggesting that there is considerable plasticity for expansion of cognitive function in older adult brains (Hallett, 2001). Third, Salthouse (2006) argued that the "use it or lose it" argument requires that an Age $\times$ Engagement interaction occur, such that differences become increasingly larger across the life span in older adults who are engaged. Although this is a reasonable prediction, it is also important to consider that cognitive engagement could broadly and positively impact the absolute level of performance at a point in time and that that performance could then be maintained over time. In this case, the enhanced abilities would continue to decline at the same rate as before the intervention, but there would be a consistent main effect over time of the group who experienced the intervention or engagement compared to the nonexperienced group. Fourth, as acknowledged by Salthouse (2006), it is possible that elders with the poorest cognitive function or from the oldest age ranges stand to benefit the most from interventions. Studies to date have not systematically examined individual differences in who benefits from training, and the impact of engagement could be masked in low ability adults as a result of the tendency for research volunteers to consist of higher functioning elders who are most able to attend multiple sessions over an extended period of time. Finally, positive effects of engagement on a range of cognitive behaviors may emerge if one considers a more fine-grained analysis of the quality of the cognitive engagement or experience, with effects occurring only under engagement conditions that make high and consistent demands in many domains of cognitive function (see "Processes Mediating Effects" for a more detailed discussion). For all of these reasons, we believe that much remains to be done to test the "use it or lose it" hypothesis. We describe below some of the important issues to be considered in designing engagement studies and discuss some completed and ongoing experimental studies of engagement.

Processes Mediating Effects

It is critical in designing engagement studies that the investigators are clear on the mechanisms that they believe control potential effects, as these will dictate the particular form of engagement manipulations selected. We hypothesize that engagement produces effects by stimulating and developing new neural pathways that did not previously exist. In line with this hypothesis, we expect that engagement effects will be maximized when individuals acquire entirely novel behaviors. Thus, we distinguish between productive and receptive engagement and argue that it is primarily productive engagement that will produce effects. This distinction is similar to the Piagetian distinction between accommodatory and assimilatory schemas (Piaget, 1937/1954). Productive engagement requires the acquisition of new skills and schemas, whereas receptive engagement involves engaging in assimilatory behaviors that utilize familiar skills and existing schemas. As an example, an older adult who learns how to play the piano for the first time would be engaging in productive engagement, whereas a skilled piano player who decided to take more lessons would be taking part in a more receptive form of engagement. It is important to recognize that the same behavior can be a form of productive engagement for one person and receptive behavior for another, depending on the skill set and behaviors that they bring to the study. We hypothesize that cognitive facilitation effects will occur primarily as a result of productive engagement in contrast to the effects of receptive engagement, which do not generally improve cognitive function in old age.

One example of a training program that relies on productive engagement is the training of older adults in theater acting (Noice & Noice, 2006; Noice, Noice, & Staines, 2004). Acting requires deep processing of character motives and interactions, and this deep engagement could extend more broadly to information processing. Research has shown that deep, meaning-based processing of information reduces age differences in memory (Eysenck, 1974) and the associated neural activations (Logan, Sanders, Snyder, Morris, & Buckner, 2002). Interpersonal aspects of acting, such as focusing on goals and interactions through a character's eyes, could further contribute to the reduction of age differences in cognition (Carstensen & Mikels, 2005). Furthermore, juggling the demands of performance taps executive function and engages multiple modalities of sensory processing. In an experimental study of theater arts as cognitive intervention, elderly adults who enrolled in a month-long training program exhibited improved recall and problem-solving ability as well as heightened well-being, and participants maintained these benefits for a posttreatment follow-up period of 4 months (Noice et al., 2004). These gains were unique to the theater arts group and did not extend to a visual arts comparison group or a no-treatment control group. It is important that the findings suggest that engagement in broad, nontraditional cognitive interventions can produce measurable effects on cognition in older adults.

One challenging aspect of training in acting is that it is a unitary process that cannot be easily subdivided into component processes (Noice et al., 2004). We recently developed a program entitled *Viva!* at the University of Illinois to study experimentally the effects of productive engagement with an intervention more amenable to eventual subdivision into component processes. After a great deal of consideration, we decided to study experimentally the impact of learning to quilt or learning to perform digital photography on cognitive function in older adults who had no experience in these domains. We chose these tasks because they afforded stimulation in motor, cognitive, and social domains. Moreover, they were complex topics on which considerable instruction could occur over prolonged periods with concrete instructional goals and resultant products that provided clear evidence of skill mastery. We asked older participants to volunteer to participate in a study in which they would be engaged for a minimum of 15 hours per week for 8 weeks, with a detailed cognitive battery administered prior to participation and near the end of participation.

Whom to Test?

Given the hypotheses under investigation, and the cost of sustaining adults in the engagement program, we tested only adults aged 60 or older. We reasoned that the effects of engagement would be greatest on older adults who had not previously been highly engaged, so, based on a preliminary screening, we selected participants who spent relatively little time outside of the home. We also selected participants who lived alone, hypothesizing that they would be less engaged than participants who lived with others. Because quilting and photography had broad appeal, we were able to get a good cross-section of volunteers in terms of socioeconomic, ethnic, and educational status. We used typical screening criteria with respect to health and cognitive status, with a minimum requirement of a Mini-Mental State Examination score of 27 and exclusion of participants who had a number of serious health conditions.

What Is the Appropriate Control Group?

One of the biggest issues when conducting engagement intervention studies is the selection of an appropriate control group. One option is to have a wait-list control, which was the strategy we adopted for our initial pilot work with *Viva!*. We called participants in the wait-list control every week and administered a busyness checklist so that we could compare levels of engagement between the two groups. The wait-list control has the advantage of being efficient and inexpensive to administer; the ACTIVE trial, the largest cognitive intervention study ever conducted, also used a wait-list control (Ball et al., 2002). The disadvantages of the wait-list control are multiple, however. If researchers observe effects in the engagement group, it is not clear what the locus of the effect is. The effect may be due to the expectation that cognition would improve, to social but not the cognitive or motor components of the engagement manipulation, or to improvements in affect that mediated findings with respect to cognition. The fact that there was no significant difference on various measures of cognitive function between the control and experimental groups in the ACTIVE trial on anything other than the trained process (i.e., speed of processing) suggests that expectation effects, if they existed, were not sufficient to change measures of cognitive function. The ACTIVE sample was very large ($N = 704$ for the control group) and was thus highly powered and very sensitive to small differences. As a result, the data from the ACTIVE trial provide considerable confidence for the assertion that it is likely not essential to include control groups that address the expectation issue. It may be useful, however, to separate the impact of social engagement alone from the social/cognitive mixture. One approach is to include a social control: a group that meets for the same amount of time, performs social activities, and participates in receptive engagement conditions (e.g., activities that are passive and do not require active learning, such as listening to lectures, going to movies or bowling, attending potlucks, etc.).

One issue that experts must consider when planning for a social or receptive control condition is that what is passive and receptive for one individual may be productive for another (e.g., going bowling if one has never bowled before). To address this issue, we considered having a group of experienced quilters meet for the same amount of time as the novice participants with an instructor who would help participants hone and refine existing skills rather than teach new skills. This group would allow us to make a comparison between experts and novices engaging in deliberate practice (Krampe & Ericsson, 1996). Although both groups would engage in sustained mental effort to acquire new skills (the defining feature of deliberate practice as described by Ericsson, Krampe, & Tesch-Romer, 1993), the novices would acquire skills in new domains of knowledge and function (and stimulate new neural assemblies), whereas the experts would refine existing skills and utilize and refine existing neural pathways, possibly by developing more efficient pathways that short-circuit less efficient pathways used when skills were lower (see Grabner, Neubauer, & Stern, 2006, for an interesting discussion of the issue of neural efficiency as it relates to intelligence and expertise). If the productive aspect of engagement is critical, one might expect the expert quilters' change in cognitive function to be intermediate between that of the novice (productively engaged) and wait-list control participants. The difference between the expert and novice groups would provide an estimate of the increment to be gained from productive compared to receptive engagement, both of which would require substantial exertion of mental effort, whereas the difference between and the expert and control groups would provide an estimate of the effects of receptive engagement. We argue that for initial studies on engagement, it is most appropriate to use a wait-list control to determine the nature of engagement effects on cognition. Once the researcher has obtained initial effects, then he or she might focus on the specific mechanisms that are exerting effects, recognizing that the whole may be greater than the sum of its parts. That is, it may be necessary to have multiple avenues of stimulation (cognitive, social, physical) to achieve beneficial effects. To the extent that this is the case, a research strategy that initially focuses on isolated mechanisms in an intervention in service of testing narrow theories of mechanism (e.g., specific cognitive abilities or particular elements of social interaction) would run the risk of missing the phenomenon entirely. Thus, in our view, the first question to address is whether the effects exist; then the researcher can unpack the effects in later studies by conducting multiple parametric manipulations of engagement.

What Behaviors Should Researchers Measure?

Given the investment made by both participants and experimenters in the lengthy engagement manipulation, it makes sense to be inclusive and have considerable breadth in the assessment of function pre- and post-engagement. We have typically included multiple measures of basic processes such as perceptual speed (e.g., Digit Comparison, Pattern Comparison;

Salthouse & Babcock, 1991), working memory (e.g., Wechsler Memory Scale Letter Number Sequencing; Weschler, 1997) verbal fluency (e.g., Controlled Oral Word Association Test; Benton & Hamsher, 1976), long-term memory (e.g., California Verbal Learning Test; Delis, Kramer, Kaplan, & Ober, 1987), and reasoning (e.g., Raven's Progressive Matrices; Raven, 1976). We have also included detailed measures of health, affect, creativity, mental flexibility, and need for cognition, and we have collected detailed information on how busy participants are and on past and present engagement. We also have found it useful to measure affect and busyness each week during the intervention in both control and experimental participants. This provides us with appropriate data to address any contextual events that occur either historically (e.g., a September 11, 2001 type of event) or personally for individual participants that may affect their engagement or cognitive function. As the research becomes more developed, we also expect that it will be worthwhile to collect structural and functional neuroimaging data to assess structural changes or differences in neural circuitry that result from the engagement manipulation.

Engagement interventions differ from traditional intervention approaches in several ways, including the breadth and intensity of the intervention. Rather than focus on training a single cognitive process (e.g., speed of processing), engagement manipulations comprise multiple components that are combined in novel ways. Furthermore, because engagement interventions exercise multiple different constructs, there may be greater potential for transfer than in traditional intervention studies. Specifically, participants are being trained to spontaneously use novel combinations of cognitive processes. The initial work we have done with *Viva!* (although still only preliminary data) as well as Noice and colleagues' (2004) theater training study demonstrate the feasibility of creating experimental models that examine the impact of sustained engagement on cognition. We believe that engagement interventions offer a promising new approach for improving cognitive function in older adults. Future research will explore the mechanisms underlying engagement effects both in terms of cognitive processes and neural activation patterns. Future research might also determine characteristics of individuals most likely to derive benefits from engagement manipulations as well as the mechanisms through which participants might sustain engagement effects over long periods of time.

Summary

We recognize that traditional cognitive training studies have much to recommend them, but we also believe that it is important to encourage the nontraditional approaches outlined here, as they can add new information to the study of cognitive facilitation. Of particular interest with respect to the approaches outlined here is the fact that older adults can easily implement them into their everyday lives if they prove to be effective. The formation of implementation intentions, a task that requires 5 minutes, appears to have the potential to enhance the probability of remembering to carry out desired behaviors for a period of weeks for a very small investment of time. We also believe the engagement approach to understanding cognitive function is tremendously important. It is time to either lay to rest the "use it or lose it" hypothesis as a folk myth or provide concrete evidence that will encourage older adults to engage in a variety of novel, stimulating activities to protect their cognitive health.

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