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Do cognitive interventions alter the rate of age-related cognitive change?☆

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ABSTRACT

There has recently been a great deal of interest in cognitive interventions, particularly when applied in older adults with the goal of slowing or reversing age-related cognitive decline. Although seldom directly investigated, one of the fundamental questions concerning interventions is whether the intervention alters the rate of cognitive change, or affects the level of certain cognitive measures with no effect on the trajectory of change. This question was investigated with a very simple intervention consisting of the performance of three versions (treatment) or one version (control) of the relevant cognitive tests at an initial occasion. Participants were retested at intervals ranging from less than 1 to 12 years, which allowed rates of change to be examined in the control and treatment groups. Although the intervention can be considered modest, participants in the treatment group had about .25 standard deviations less negative cognitive change over an interval of approximately three years than those in the control group, which is comparable to effect sizes reported with more intensive interventions. However, there were no interactions of the intervention with length of the interval between occasions, and thus there was no evidence that the intervention affected the course of age-related cognitive decline.

1. Introduction

Many different types of interventions, ranging from training on specific tasks to engagement in stimulating activities, have been found to lead to higher levels of performance in cognitive tasks (e.g., see reviews in Gross et al., 2012; Hindin & Zelinski, 2012; Jak et al., 2013; Karr et al., 2014; Kelly et al., 2014; Kueider et al., 2012; Lampit et al., 2014; Martin et al., 2011; Noack et al., 2009; Papp et al., 2009; Reijnders et al. 2012). Although reviewers differ in their estimates of the magnitude of the intervention effects, there is a consensus that cognitive interventions can be effective in increasing the level of performance in the trained tasks.

A number of intervention studies have also investigated effects of the intervention on new measures of cognitive functioning. As noted in several of the reviews cited above, the pattern of findings with transfer tests has been mixed, with some reports of significant benefits of the intervention on new tests, and other reports of little or no benefits.

Although results with untrained tasks are informative about the generalizability of intervention outcomes, the most relevant evidence for evaluating whether interventions affected age-related change concerns the trajectory of change after an intervention. Possible outcomes after an intervention has produced increases in the level of cognitive performance are illustrated in Fig. 1. Note that the critical information for distinguishing among the alternatives is not the level of performance immediately after the intervention, or the level of performance at any particular interval after the intervention, but instead the relation between performance and time since the intervention. Only if the rate of change after the intervention differs from that before the intervention, or in the absence of the intervention, could one conclude that the intervention altered age-related cognitive decline.

Because of the considerable time and expense needed to monitor cognitive performance at different intervals after an intervention, only a limited number of studies have conducted follow-up assessments with intervals greater than a few years, which may be the minimum interval necessary to detect age-related cognitive decline. Moreover, the primary interest in these studies has been the persistence or maintenance of the intervention effect, corresponding to the difference between treatment and control conditions at a particular interval after the intervention, and not whether there is an effect on age-related decline, as reflected in the slope of the function relating cognitive change to time since the intervention.

One study with data relevant to effects on rates of cognitive change is the ACTIVE project, in which the interventions consisted of 10 60–75 min sessions of memory, reasoning, or speed training. A unique feature of this project was multiple follow-up assessments up to 10 years after the intervention. Results across all measurement occasions were recently summarized in Fig. 2 in Rebok et al. (2014). Although no statistical comparisons of the slopes were reported, the rate of decline between 3 and 10 years after the intervention appeared to be nearly the same in the three training groups and in the control group for all three outcome measures, i.e., memory, reasoning, and speed. There was therefore no indication in the graphical results that

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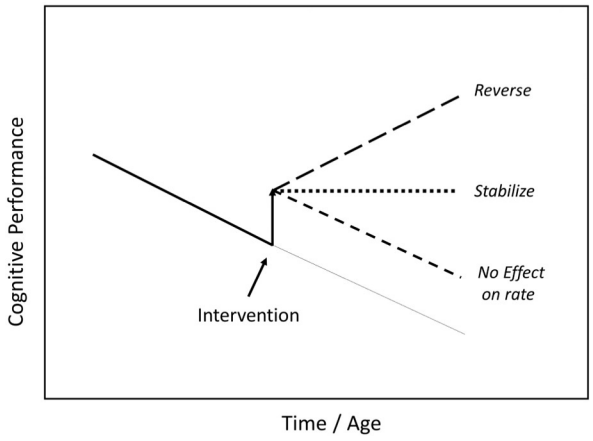

Fig. 1. Schematic illustration of possible outcomes on rate of cognitive change before and after an intervention found to increase level of cognitive performance.

the rate of change varied according to the presence, or nature, of the intervention.

A possible complication in interpreting the rate-of-change results of the ACTIVE study is that all of the participants received multiple assessments, and some received additional training, between the first and last assessment. This is a potential problem because the additional assessments and training could have altered the cognitive change trajectory. In fact, a recent study found that adults within this age range exhibited significant negative change when there was no intervening assessment between the first and last measurements, but the change was not significantly different from zero when an additional assessment occurred during the interval (Salthouse, 2014a). Repeated assessments can be a particular concern in the interpretation of intervention studies if the effects are primarily attributable to greater assessment-related performance gains in the treatment group than in the control group, with little or no influence of the intervention on fundamental processes of cognitive functioning.

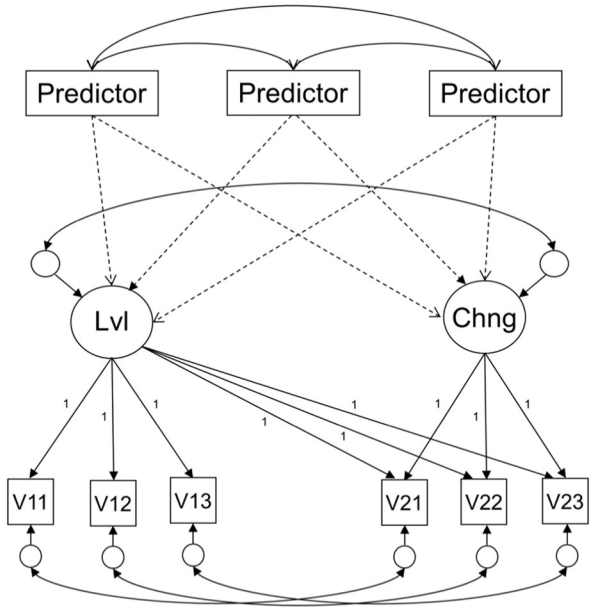

Fig. 2. Illustration of the latent change model used to assess cognitive change from the first to the second longitudinal occasion. The boxes correspond to the scores on the three tests assumed to represent each ability at the first (i.e., V1x) and second (i.e., V2x) occasions, and the circles correspond to the latent level (Lvl) and latent change (Chng) variables. Unlabeled circles represent residual variances.

Because there is no possibility of an influence of intervening assessments when everyone is only tested twice, one solution to the reactive measurement problem, in which the change trajectory may be distorted if participants are repeatedly assessed, is to rely on data from different individuals at each interval. Comparisons of this type were reported in a recent study in which participants returned for the second longitudinal occasion at variable intervals after the initial occasion (Salthouse, 2011). As one would expect, the change was progressively more negative as the interval between occasions increased.

Another article (Salthouse, 2013a) based on the same Virginia Cognitive Aging Project (VCAP) data set compared the longitudinal changes of participants who performed one version of the relevant tests at the initial occasion with the changes of participants who performed three versions of the tests. This additional experience can be considered an intervention, albeit modest compared to that in studies with more intensive training or engagement. Nevertheless, this simple practice intervention was effective in altering subsequent performance because participants with three versions of the tests at the initial occasion had less negative change over an interval of three years than participants with only one version at the initial occasion.

The purpose of the current study was to use updated longitudinal data from the VCAP data set to compare the cognitive change trajectories in a treatment (three versions of the tests) group and in a control (one version of the tests) group. The primary analyses compared the treatment and control groups with respect to the relation between cognitive change and the interval between the first (T1) and second (T2) occasions. Persistence of the intervention effects was also examined in a subsample of participants with an average interval of over 5 years. Transfer effects were investigated by comparing performance of the treatment and control groups on new measures of cognition assessed for the first time at the second occasion. In addition, intervention effects on broader aspects of functioning were examined with subjective measures of memory, thinking, and mood (anxiety, depressive symptoms), and life satisfaction. Finally, because some of the participants returned for a third (T3) occasion, effects of the intervention across the T2-T3 interval were also examined to investigate the durability of the intervention effects.

Initial effectiveness of the intervention was evaluated by the change in performance across alternate versions of the tasks administered on the second and third sessions of the first occasion. Relatively small gains were evident in tests of vocabulary and reasoning (Salthouse, 2013b), and because there was little evidence that the intervention was effective for these measures, only measures of memory, speed, and spatial visualization were included in the subsequent analyses.

Two types of analyses were conducted to examine the robustness of the results. One type was based on composite scores, with age and the interval between occasions both treated as categorical variables in analyses of variance. The other type of analysis involved estimates of latent change as the outcome variables, with age and interval treated as continuous predictor variables in regression analyses.

2. Method

2.1. Sample

Characteristics of the participants included in the analyses are reported in Table 1. Only individuals between 18 and 80 years of age with MMSE (Folstein et al., 1975) scores greater than 26 at the second occasion were included in the analyses to emphasize healthy aging.

On each occasion the participants reported to the laboratory for three sessions within a period of about 2 weeks. About one-half of the participants performed different types of cognitive tests on the second and third sessions, and the remaining participants performed alternate versions of the same tests on all three sessions (in a measurement burst design). Assignment of participants to one or three versions at the initial occasion was determined by the research goals at the time