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Intervention Research

Personality Moderates Intervention Effects on Cognitive Function: A 6-Week Conversation-Based Intervention

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Abstract

Background and Objectives: Social isolation is associated with a higher risk of dementia. We previously conducted and showed the efficacy of an intervention which uses conversation (the core component of social interactions) as a tool to enhance cognitive function. We now explore whether cognitive improvements through conversation-based intervention depend on an individual's personality.

Research Design and Methods: We reexamined data from a 6-week randomized controlled trial (ClinicalTrials.gov Number: NCT01571427) to determine whether conversation-based intervention effects were moderated by personality traits in 83 older adults (mean age = 80.51 years, 49 cognitively intact, 34 individuals with mild cognitive impairment). The intervention group participated in daily 30-min face-to-face semi-structured conversations with trained interviewers through a web-enabled system for 6 weeks. At baseline, psychosocial questionnaires and a neuropsychological battery were completed.

Results: Intervention group participants with high agreeableness, conscientiousness, and extraversion exhibited significant improvements in language-based executive function tasks beyond changes in the control group ($ps < .05$). An opposite pattern for delayed recall memory and working memory tasks emerged among highly extraverted participants ($ps < .05$).

Discussion and Implications: Our exploratory findings suggest the adaptive role of personality traits in conversation-based cognitive interventions may be limited to tasks incorporating a language component, and offer initial evidence for personalized approaches to cognitive health in late life.

Keywords: Clinical trial methods, Cognition, Intervention, Personality traits, Social engagement

Social engagement and larger social networks are thought to be key contributors to cognitive health and dementia prevention efforts (e.g., Bennett, Schneider, Tang, Arnold, & Wilson, 2006; Dodge, Ybarra, & Kaye, 2014; Fratiglioni, Paillard-Borg, & Winblad, 2004; Zhou, Wang, & Fang, 2018). Associations between social contact and cognition, however, may depend upon relatively enduring personality traits (e.g., Segel-Karpas & Lachman, 2018). Recent clinical work has demonstrated face-to-face conversation-based intervention can enhance cognitive function in late life (Dodge et al., 2015), but it remains unclear whether improvements in cognitive function depend on an individuals' personality characteristics.

Neurobehavioral Links Between Personality and Cognition

Personality traits are predictive of significant individual outcomes (e.g., health, mortality) and interpersonal outcomes (e.g., personal relationship quality, social engagement) across the lifespan (Ozer & Benet-Martínez, 2006). The "Big Five" model of personality (Costa & McCrae, 1992) defines neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness as the five primary personality traits. Each of these relatively enduring characteristics of one's thoughts, feelings, and actions are important predictors of cognitive health in older adulthood, as outlined below.

Neuroticism

Neuroticism is the tendency to worry, feel anxious, and be prone to experiencing depressive symptoms (John & Srivasta, 1999). Among community-dwelling older adults, lower neuroticism scores are linked to better attention, visual-spatial function and executive function (EF; Chapman et al., 2017; Williams, Suchy, & Kraybill, 2010), and verbal fluency (Sutin et al., 2011). Higher neuroticism is linked to smaller regional brain volume, and steeper volume declines with increased age (Jackson, Balota, & Head, 2011), as well as Alzheimer's disease risk (Duberstein et al., 2011; Terracciano et al., 2014) and dementia risk (Terracciano, Stephan, Luchetti, Albanese, & Sutin, 2017).

Extraversion

Individuals high in extraversion are characterized as more sociable, active, and adventurous (John & Srivasta, 1999) and more likely to have social support (Russell, Booth, Reed, & Laughlin, 1997). Crowe, Andel, Pedersen, Fratiglioni, and Gatz (2006) showed moderate extraversion, lower neuroticism, and a combination of lower extraversion and higher neuroticism were associated with a lower risk of cognitive impairment.

Openness to Experience

Individuals who are open to experience are intellectually curious, imaginative, and artistic (John & Srivasta, 1999). Higher openness has been shown to be associated with better EF (Williams et al., 2010), verbal fluency (Sutin et al., 2011), delayed recall, language functioning (Chapman et al., 2017), verbal ability, spatial ability, memory, processing speed, and global cognition (Sharp, Reynolds, Pedersen, & Gatz, 2010) in community-dwelling older adults. Higher openness has also been shown to be related to having a lower risk of Alzheimer's disease using longitudinal data with up to 6 years follow-up (Duberstein et al., 2011) and up to 22 years follow-up (Terracciano et al., 2014).

Agreeableness

Individuals who are agreeable are trusting, altruistic, and accommodating (John & Srivasta, 1999). Higher agreeableness is associated with better EF (Williams et al., 2010), verbal fluency (Sutin et al., 2011), as well as lower Alzheimer's disease risk (Terracciano et al., 2014) and lower overall dementia risk (Terracciano et al., 2017).

Conscientiousness

Individuals with high levels of conscientiousness are characterized as more organized, goal-oriented, and self-disciplined (John & Srivasta, 1999). Higher conscientiousness has been linked to greater brain volume and less volume decline with increased age in healthy middle-aged and older adults (Jackson et al., 2011). Additionally, reporting higher conscientiousness is associated with better delayed recall memory performance, EF, and attention in community-dwelling older adults (Chapman et al., 2017).

Decreases in conscientiousness, as well as increases in neuroticism have been identified in participants with very mild Alzheimer's disease compared with healthy participants, perhaps serving as indicators of early-stage Alzheimer's disease (Duchek, Balota, Storandt, & Larsen, 2007). Additionally, recent results from longitudinal studies show that lower conscientiousness has been linked to increased dementia risk (Terracciano et al., 2017), greater risk of Alzheimer's disease using data with up to 6 years follow-up (Duberstein et al., 2011), and a threefold increased risk of Alzheimer's disease for individuals in the lowest quartile of conscientiousness using data with up to 22 years follow-up (Terracciano et al., 2014). In a clinical cohort study with up to 12 years follow-up, Catholic nuns, priests, and brothers who scored in the 90th percentile of conscientiousness had an 89% reduction in Alzheimer's disease risk compared with those in the 10th percentile of conscientiousness (Wilson, Schneider, Arnold, Bienias, & Bennett, 2007).

Taken together, these known associations among personality traits and cognitive function in older adults (e.g., Williams et al., 2010) necessitate consideration of an individuals' personality when constructing cognitive interventions to maximize intervention efficacy (e.g., Payne et al., 2012) and adherence (e.g., Payne et al., 2012; Stine-Morrow et al., 2014).

Personality as a Moderator of Cognitive Intervention Efficacy

Prior cognitive intervention efforts have shown that personality characteristics can modify intervention effects and maximize protocol adherence among older adults. Training with a computer-aided mnemonic learning device showed improvements in list recall among older adults with higher levels of openness (Finkel & Yesavage, 1989). In a sample

of community-dwelling older adults, Gratzinger, Sheikh, Friedman, and Yesavage (1990) compared improvements in face-name recall in three imagery mnemonic training groups that differed in their pre-training exercise (imagery, relaxation, or imagery and judgment). The fantasy domain of openness moderated intervention effects such that individuals with higher fantasy levels in the imagery treatment group showed greater improvement in face-name recall (Gratzinger et al., 1990).

Recent additions to the cognitive intervention known as the Senior Odyssey project allowed for a comparison between the intervention effects of a training model (task-specific instruction and practice) and engagement model (embedding participants in intellectually and socially complex environments) in older adults (Stine-Morrow et al., 2014). Among the engagement model group, which included team meetings and problem-solving games, levels of openness and social network size moderated intervention effects such that individuals with higher openness and greater social network size showed larger gains in divergent thinking.

A 4-week working memory (WM) training intervention in a sample of young adults showed that higher conscientiousness was linked to greater single *n*-back performance, and individuals with lower neuroticism benefitted most from dual *n*-back training, whereas individuals with higher neuroticism benefitted most from single *n*-back training (Studer-Luethi, Jaeggi, Buschkuehl, & Perrig, 2012). In an older adult sample, however, Guye, De Simoni, and von Bastian (2017) did not find any personality trait moderation of WM training intervention effects.

In the conversation-based intervention examined in the present study, certain personality traits may be especially relevant to consider for the promotion of intervention effects. Recent work by Segel-Karpas and Lachman (2018) showed that associations between social contact and cognition may depend upon relatively enduring personality traits. Across adults aged 32–84, higher extraversion and lower openness strengthened social contact–episodic memory associations and social contact–EF associations. Segel-Karpas and Lachman (2018) argued that individuals high in extraversion may require social contact for cognitive stimulation compared with individuals high in openness that obtain stimulation by other means. Thus, studies have shown that personality plays an important role in understanding not only who may benefit most from a cognitive intervention, but also who may respond best to particular content delivered within the intervention protocol.

The Present Study

Previous research has demonstrated the substantive links between personality traits and cognitive function (e.g., Chapman et al., 2017) and their moderating role in cognitive interventions (e.g., Stine-Morrow et al., 2014). However, no research has directly examined the moderating role of personality traits in a conversation-based intervention aimed to enhance cognitive function, explicitly elucidating ways to maximize intervention effectiveness.

The primary objective of this exploratory study was to examine whether conversation-based intervention effects on multiple cognitive domains depend on levels of neuroticism, extraversion, openness, agreeableness, and conscientiousness in older adults. Do personality traits moderate the conversation-based intervention effect on cognitive function at the post-intervention assessment of the study (18 weeks post-baseline)? Based on prior research, we hypothesized that individuals with higher levels of extraversion, openness, agreeableness, and conscientiousness, and lower levels of neuroticism would benefit most from the conversation-based intervention on cognitive function.

Methods

Subject Recruitment and Randomization

Data were from a 6-week conversation-based randomized controlled trial (ClinicalTrials.gov Number: NCT01571427) conducted between 2011 and 2012 in the Portland, OR metropolitan area. A flow chart of each stage of the intervention protocol is shown in Figure 1. Participants were recruited from 16 retirement communities and senior centers within a 60-min drive from the Oregon Health and Science University. Information sessions were provided at each site to describe the trial and also distribute 2,000 survey questionnaires with a section where individuals could include contact information if

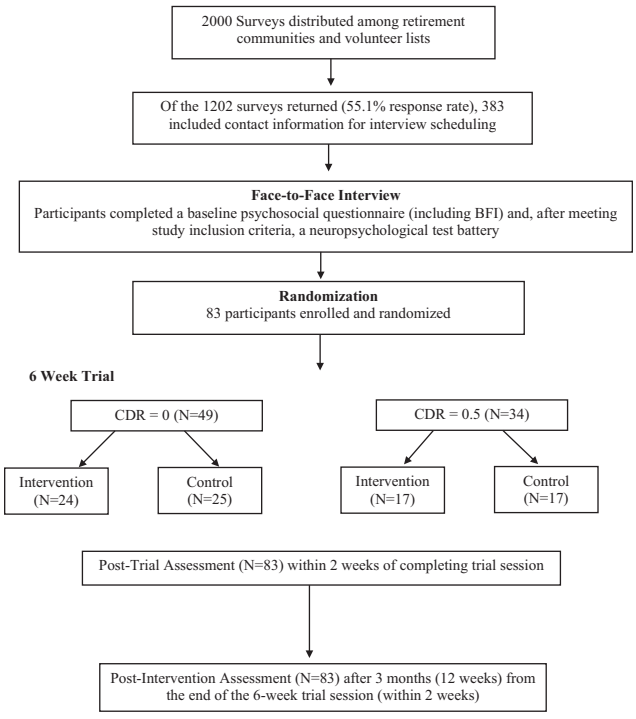

Figure 1. Study flow chart. BFI = Big Five Inventory; CDR = Clinical Dementia Rating.

interested in participating in the trial (Dodge et al., 2014). Face-to-face baseline screening interviews were conducted by trained research associates on the 383 individuals who expressed interest in participating in the trial.

Inclusion criteria included ≥70 years of age, a Clinical Dementia Rating (CDR; Morris, 1993) of 0 or 0.5, adequate general health status, and vision, hearing, and English language skills sufficient enough to complete neuropsychological tests. Exclusion criteria included a plan to participate in new classes, travel or significant social events (e.g., wedding) during the trial, and neurodegenerative diseases and other conditions that would make participation in the intervention difficult (for detailed lists of inclusion and exclusion criteria, see Dodge et al., 2015).

Eighty-three participants were randomly assigned to the control or intervention group using a minimization algorithm (Schouten, 1995) balancing across age, sex, CDR, Mini-Mental State Examination (MMSE) score (Folstein, Folstein, & McHugh, 1975), and years of education. Cognitively intact individuals and individuals with mild cognitive impairment (MCI) were operationally defined by CDR scores of 0 and 0.5, respectively (Morris, 1993). Individuals with a CDR of 0.5 met criteria consistent with a widely used definition of MCI (Petersen, 1999) that demonstrates a generally preserved ability to carry out daily activities amid neuropsychological impairment in memory. Table 1 provides baseline participant characteristics across demographic, personality, and neuropsychological domains.

Protocol of Conversation-Based Intervention

Using a dedicated user-friendly video-chat-enabled personal computer (PC), intervention group members engaged in 30–35 min of face-to-face conversations with trained interviewers 5 days a week (Monday–Friday) for 6 weeks. These touch screen PCs were preconfigured to receive calls with a single touch and automatically begin conversation sessions to ensure ease of use and to prevent stimulation effects from PC usage. Control group members received weekly 10-min telephone calls to monitor their social engagement activities during the previous week and increase their retention in the study. The neuropsychological test battery was administered within 2 weeks before starting the trial (baseline), within 2 weeks after completing the trial (~6 weeks post-baseline), and at the post-intervention assessment point (18 weeks post-baseline). All participants completed the neuropsychological test battery at each of these three time points.

Brief semi-structured conversation sessions with trained interviewers were designed to be 30–35 min long and primarily engage participants' EF, attention, semantic memory, and abstract reasoning by placing emphasis on spontaneous responses instead of structured answers (i.e., participants had to organize their own thoughts). Daily picture prompts (e.g., Norman Rockwell paintings, the first moon landing) were used in each session to stimulate conversation and provide some degree of standardization. Participants were asked about what was happening in the picture prompt and if they can connect their experience with the story observed in the picture. The unstructured component of the conversation involved reminiscence (e.g., talking about the participants' childhood memories, hobbies, siblings, parents, movies, books) and expressing opinions on contemporary issues (e.g., pros and cons of using social media). The study showed high adherence. No drop out occurred during the intervention period and participants, on average, completed 89% of the conversation sessions (range: 77%–100%).

Measures

Personality traits.

Baseline personality was measured by the Big Five Inventory (BFI; John & Srivasta, 1999). This 44-item inventory measured levels of an individuals' neuroticism (8 items, "gets nervous easily"), extraversion (8 items, "outgoing, sociable"), openness (10 items; "curious about many different things"), agreeableness (9 items, "likes to cooperate with others"), and conscientiousness (9 items, "makes plans and follows through with them"). Answered on a 5-point Likert-type scale, the BFI ranges from 1 (*strongly disagree*) to 5 (*strongly agree*). Total scores for each trait subscale indicated the degree in which participants exhibited the trait with higher scores reflecting the greater display of the trait. In the present study, the BFI demonstrated adequate internal consistency for openness (α = .77), conscientiousness (α = .79), extraversion (α = .80), agreeableness (α = .79), and neuroticism (α = .80) trait subscales.

Cognitive outcomes.

Baseline, post-trial, and final assessments of eight cognitive domains were measured via 10 neuropsychological tests. A category fluency test (naming as many animals in 60 s; Lezak, Howieson, Bigler, & Tranel, 2012) and letter fluency test (naming as many words that begin with "F," "A," and "S" in 60 s; Lezak et al., 2012) assessed language-based EF. The Stroop task (naming ink color when incongruent color words are presented; Lezak et al., 2012) assessed sustained attention/response inhibition. Trail Making Test A (drawing a line connecting numbers in order; Reitan, 1958) assessed psychomotor speed. Trail Making Test B (drawing a line of alternative numbers and letters in sequence; Reitan, 1958) assessed EF. The Consortium to Establish a Registry for Alzheimer's Disease Word List task (listing as many words as participants can recall immediately and after a distraction task; Morris et al., 1989) assessed immediate recall and delayed recall memory, respectively. Performance on three computerized Cogstate tests were also examined due to their known sensitivity to early cognitive decline (Darby, Brodtmann, Woodward, Budge, & Maruff, 2011). N-back accuracy tests, reporting congruence with the

Table 1. Baseline Descriptive Statistics for Full Sample and Differences/Commonalities Across Intervention and Control Group, Cognitively Intact, and MCI

Variable	Full (*N* = 83)	Intervention (*N* = 41)	Control (*N* = 42)	*p*	CDR = 0 (*N* = 49)	CDR = 0.5 (*N* = 34)	*p*
Age	80.51 (6.85)	80.85 (7.17)	80.17 (6.59)	.6505	78.92 (5.3)	82.78 (7.93)	.0103
Female (%)	75.90	78.05	73.81	.6516	71.43	82.35	.2524
Years of education	16.01 (2.60)	16.07 (2.40)	15.94 (2.81)	.8180	16.59 (2.55)	15.16 (2.48)	.0129
CDR = 0.5 (%)	40.96	41.46	40.48	.9271	—	—	—
MMSE	28.28 (1.76)	28.24 (1.71)	28.31 (1.81)	.8660	28.94 (1.33)	27.32 (1.87)	<.0001
Married (%)	46.34	45.00	47.62	.8121	52.08	38.24	.2154
Category fluency	19.93 (5.10)	19.46 (5.26)	20.38 (4.95)	.4155	21.76 (4.64)	17.29 (4.60)	<.0001
Letter fluency	37.37 (12.98)	37.05 (13.24)	37.69 (12.88)	.8235	39.12 (11.95)	34.85 (14.15)	.1417
Word list acquisition	18.96 (4.47)	19.00 (4.76)	18.93 (4.22)	.9415	20.21 (3.70)	17.21 (4.91)	.0022
Word list delayed recall	4.79 (2.31)	4.80 (2.25)	4.78 (2.40)	.9623	5.65 (1.99)	3.59 (2.22)	<.0001
Trail Making Test A	41.28 (15.84)	44.61 (17.02)	37.95 (13.99)	.0565	36.37 (11.31)	48.58 (18.75)	.0004
Trail Making Test B	120.15 (62.25)	123.10 (60.52)	117.40 (64.47)	.6803	102.90 (45.67)	144.50 (74.13)	.0023
Stroop	29.33 (8.70)	29.90 (10.52)	28.76 (6.55)	.5537	31.98 (7.90)	25.50 (8.47)	.0006
Detection	2.60 (0.09)	2.61 (0.11)	2.60 (0.07)	.4440	2.60 (0.10)	2.61 (0.09)	.7232
1-back	1.16 (0.15)	1.15 (0.16)	1.17 (0.15)	.7515	1.18 (0.14)	1.12 (0.17)	.0825
2-back	1.06 (0.18)	1.06 (0.14)	1.07 (0.20)	.7810	1.09 (0.17)	1.03 (0.18)	.1282
Extraversion	3.48 (0.82)	3.36 (0.78)	3.61 (0.84)	.1590	3.54 (0.85)	3.42 (0.77)	.4726
Agreeableness	4.29 (0.61)	4.15 (0.66)	4.42 (0.52)	.0473	4.29 (0.60)	4.28 (0.62)	.9743
Conscientiousness	3.91 (0.71)	3.97 (0.78)	3.85 (0.64)	.4587	3.93 (0.75)	3.87 (0.65)	.6884
Neuroticism	2.32 (0.82)	2.45 (0.92)	2.19 (0.69)	.1452	2.29 (0.81)	2.35 (0.85)	.7688
Openness	3.99 (0.63)	3.96 (0.64)	4.02 (0.63)	.6526	4.40 (0.595)	3.98 (0.69)	.8458

Note. CDR = Clinical Dementia Rating; MMSE = Mini-Mental State Examination. Data presented as mean (*SD*) unless labeled as a percentage (%).

stimuli presented 1 (1-back) or 2 (2-back) slides previously (Darby et al., 2011), assessed WM. The Detection task (pressing "Yes" as soon as a stimulus appears; Darby et al., 2011) assessed psychomotor speed. For all tests except the Detection task and Trail Making Tests A and B, higher scores indicated better cognitive performance. Higher scores on the Detection task and Trail Making Tests A and B indicated worse performance.

Analytic Strategy

We used hierarchical linear regression analyses with study group by personality trait interaction terms to determine whether personality traits moderated intervention effects on cognitive function. First, we regressed the cognitive outcome from the post-intervention assessment (18 weeks post-baseline assessment) on study group (0 = *control*, 1 = *intervention*), CDR (0 = *intact*, 0.5 = *MCI*) to account for differences in cognitive performance based on cognitive status, and baseline cognitive performance for the particular outcome (e.g., regressing category fluency on study group, CDR, and baseline category fluency performance). Next, we added the personality trait of interest and the study group by personality trait interaction in the second model to assess the additional variance personality traits explained in each cognitive outcome above and beyond influences of study group, cognitive status, and baseline cognitive performance for the particular outcome. This regression equation was repeated five times for each cognitive outcome to assess each personality trait as a potential moderator.

Results

Table 1 includes all descriptive statistics for primary study variables among the full sample and stratified by study group and cognitive status. A correlation matrix for all cognitive outcomes is provided as Supplementary Material. Age, sex, education, CDR, MMSE score, and marital status were statistically comparable between intervention and control groups. When stratifying by CDR, individuals with MCI were significantly older, completed fewer years of education, scored lower on the MMSE and performed worse on all neuropsychological tests except letter fluency, detection, and *n*-back accuracy tasks. Levels of each personality trait were statistically comparable across study group and cognitive status except for higher levels of agreeableness in the control group compared with the intervention group.

Results from initial regression models used to assess ΔR^2 are provided as Supplementary Material. See Dodge and colleagues (2015) for complete reporting of intervention effects before examining the role of personality.

Including the study group by personality trait interaction terms explained 0%–7% additional variance in the cognitive outcomes (Table 2), with significant additional variance explained in category fluency [conscientiousness; ΔR^2 = .05, $F(2, 75) = 3.52$, $p < .05$], letter fluency [extraversion; ΔR^2 = .02, $F(2, 74) = 3.30$, $p < .05$], delayed recall [extraversion; ΔR^2 = .04, $F(2, 74) = 4.08$, $p < .05$), Trail Making Test A (openness; ΔR^2 = .04, $F(2, 75) = 3.32$, $p < .05$), 1-back (agreeableness; ΔR^2 = .07, $F(2, 70) = 3.56$, $p < .05$), and 2-back tasks (extraversion; ΔR^2 = .07, $F(2, 70) = 3.16$, $p < .05$).

Moderation Analyses

Evidence of personality moderation emerged for the intervention effect on category fluency, letter fluency, delayed recall, Trail Making Test B, and 2-back performance 18 weeks post-baseline assessment (Table 2). For individuals with relatively high conscientiousness (+1 *SD* above the mean of 3.91), being in the intervention group was associated with a 3.52-point increase in category fluency performance beyond changes in the control group ($b = 3.52$, $SE = 1.35$, $p < .05$; Figure 2). For individuals with relatively high agreeableness (+1 *SD* above the mean of 4.29), being in the intervention group was associated with a 6.06-point increase in letter fluency performance beyond changes in the control group ($b = 6.06$, $SE = 2.40$, $p < .05$). For individuals with relatively high extraversion (+1 *SD* above the mean of 3.48), being in the intervention group was associated with a 5.77-point increase in letter fluency performance ($b = 5.77$, $SE = 2.32$, $p < .05$; Figure 3), a 1.52-point decrease in delayed recall performance ($b = -1.62$, $SE = .59$, $p < .01$), a 30.73-point increase in time to complete Trail Making Test B ($b = 30.73$, $SE = 13.47$, $p < .05$), and a 0.11-point decrease in 2-back performance ($b = -.11$, SE = .04, $p < .05$) beyond changes in the control group. No personality moderation emerged for the intervention effect on word list acquisition, Trail Making Test A, Stroop, detection, and 1-back performance.

Discussion

Participating in conversations require linguistic ability, attention, WM, and social cognition (e.g., Ybarra et al., 2008), thereby making conversation-based intervention a practical way of promoting cognitive function in late life (Dodge et al., 2015). Our exploratory results from this randomized controlled trial suggest alignment of one's personality and cognitive domains may be paramount to maximizing conversation-based intervention efficacy in late life. Evidence of moderation offered partial support for a priori hypotheses, suggesting domains of personality and cognitive function are important to consider when designing conversation-based cognitive interventions in adults 70 years of age and older. Individuals with high extraversion, agreeableness, and conscientiousness may

Table 2. Linear Regressions Predicting Cognitive Performance 18 Weeks Post-Baseline Assessment

Variable	Category fluency	Letter fluency	Word list acquisition	Word list delayed recall	Trail Making Test A	Trail Making Test B	Stroop	Detection	1-Back	2-Back
Trait × Group	Est. (*SE*)	Est. (*SE*)	Est. (*SE*)	Est. (*SE*)	Est. (*SE*)	Est. (*SE*)	Est. (*SE*)	Est. (*SE*)	Est. (*SE*)	Est. (*SE*)
E × Group	0.47 (1.22)	4.22 (2.02)*	0.09 (0.91)	−1.40 (0.52)**	1.42 (3.30)	28.44 (11.77)*	−0.30 (1.31)	0.05 (0.02)	−0.02 (0.04)	−0.07 (0.03)*
A × Group	2.47 (1.67)	5.71 (2.85)*	−0.48 (1.28)	0.32 (0.75)	−4.05 (4.51)	8.16 (16.76)	−1.76 (1.82)	0.02 (0.03)	−0.07 (0.05)	−0.02 (0.05)
C × Group	2.92 (1.37)*	3.49 (2.43)	0.58 (1.09)	0.30 (0.65)	6.13 (3.74)	25.31 (14.17)	−0.70 (1.54)	0.02 (0.03)	−0.01 (0.04)	0.00 (0.04)
N × Group	−1.85 (1.22)	−1.91 (2.19)	0.25 (0.91)	−0.02 (0.54)	−0.04 (3.35)	1.41 (13.16)	1.11 (1.32)	−0.01 (0.02)	−0.04 (0.04)	0.05 (0.15)
O × Group	−0.38 (1.51)	2.67 (2.60)	−1.12 (0.34)	−0.43 (0.68)	7.44 (3.89)	27.00 (15.13)	0.10 (1.64)	−0.00 (0.03)	−0.08 (0.04)	−0.04 (0.04)
R^2	.44–.49	.74–.76	.60–.61	.59–.63	.49–.53	.36–.41	.71	.23–.27	.19–.26	.16–.23
ΔR^2	.00–.05	.01–.02	.00–.01	.00–.04	.00–.04	.02–.05	.00	.00–.04	.00–.07	.00–.07

Note. E = extraversion; A = agreeableness; C = conscientiousness; N = neuroticism; O = openness. Group = study group (0 = *control*, 1 = *intervention*). Models adjusted for baseline cognitive performance for the particular outcome, cognitive status, study group, and personality trait. ΔR^2 = Change in R^2 after adding the study group by personality trait interaction term to base model (study group, cognitive status, and baseline cognitive performance, cognitive status).
*$p < .05$, **$p < .01$.

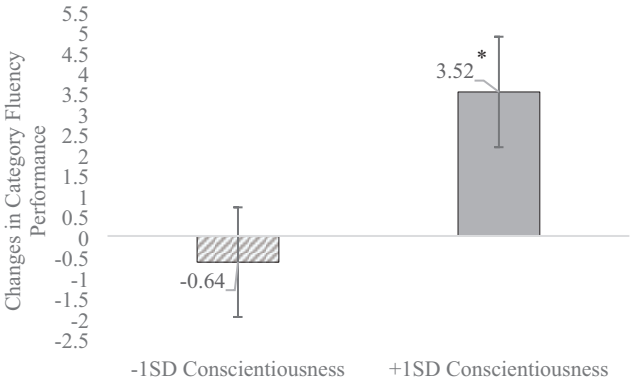

Figure 2. Intervention-related increase/decrease in category fluency performance among individuals with low (−1 *SD*) and high (+1 *SD*) conscientiousness. For individuals with relatively high conscientiousness, being in the intervention group was associated with a 3.52-point increase in category fluency performance beyond changes in the control group ($b = 3.52$, $SE = 1.35$, $p < .05$).

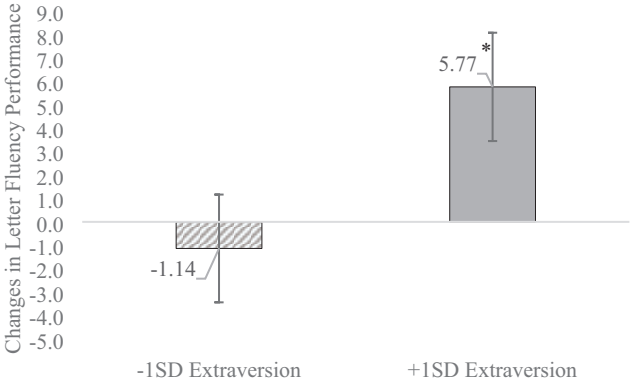

Figure 3. Intervention-related increase/decrease in letter fluency performance among individuals with low (−1 *SD*) and high (+1 *SD*) extraversion. For individuals with relatively high extraversion, being in the intervention group was associated with a 5.77-point increase in letter fluency performance ($b = 5.77$, $SE = 2.32$, $p < .05$).

benefit most from conversation-based interventions that target language-based EF. Importantly, those with high extraversion participating in conversation protocols may experience deleterious influences on delayed recall memory and WM.

Personality Moderation of Intervention Effects Depends on Cognitive Domain

Extraversion

An increase in language-based EF emerged in participants with relatively high extraversion, consistent with expectations that more sociable and adventurous individuals would benefit from a conversation-based protocol. Participating in conversations may be a useful way for extraverted individuals to promote their cognitive health as recent work suggests these individuals may require social contact for cognitive stimulation (Segel-Karpas & Lachman, 2018). Importantly, being high in extraversion did not uniformly benefit cognitive function among intervention participants. Those high in extraversion also exhibited decreases in delayed recall memory and WM performance, suggesting the adaptive role of extraversion may be limited to tasks incorporating a language component such as the current study's letter fluency task (i.e., naming as many words that begin with certain letters). Perhaps extraverted individuals in the current study lost interest in the nonconversational Trail Making Test B and computerized *n*-back WM task and may have failed to pay full attention to the delayed recall memory task following the distraction stimuli.

Agreeableness

Participants with relatively high agreeableness exhibited increases in language-based EF, consistent with literature linking higher agreeableness to better EF (Williams et al., 2010), verbal fluency (Sutin et al., 2011), and lower dementia risk (e.g., Terracciano et al., 2017). The trusting and accommodating aspects of these participants may have led to increased engagement in the intervention protocol and contributed to enhanced intervention effects.

Conscientiousness

Consistent with studies linking higher conscientiousness with better EF in community-dwelling older adults (e.g., Chapman et al., 2017) and greater training-related WM performance in young adults (Studer-Luethi et al., 2012), participants with relatively high conscientiousness benefitted from the intervention in language-based EF. Individuals who are goal-oriented, organized, and self-disciplined may be more likely to maintain commitment to the 6-week intervention protocol. Further, Jackson and colleagues (2011) linked high levels of conscientiousness with less brain volume decline with increased age. The participants in the current study with relatively high conscientiousness could be exhibiting a protective personality profile consistent with previous accounts of high conscientiousness associated with reductions in Alzheimer's disease risk (e.g., Wilson et al., 2007) and low conscientiousness associated with increases in dementia risk (e.g., Duberstein et al., 2011; Duchek et al., 2007; Terracciano et al., 2017).

It was surprising that neuroticism and openness did not moderate intervention effects. It is possible the straightforward and easy-to-use web-enabled conversational system diffused any anxiety or concerns from individuals with high neuroticism. The conversational system was designed for all individuals regardless of computer experience, and technical support personnel set up the equipment for each participant in their home (Dodge et al., 2014). Further, although individuals with high openness are more intellectually curious, imaginative, and artistic, it is possible that the semi-structured interview with daily picture prompts created a standardization that minimized the opportunity for variability in openness to influence a participant's experience.

Implications for Personalized Cognitive Interventions

Social engagement is a modifiable lifestyle factor that is robustly linked to risk of dementia in older adulthood (e.g., Bennett et al., 2006; Zhou et al., 2018). Indeed, recent longitudinal work among Chinese older adults showed that a 1-unit increase in social engagement was associated with a 29% reduced risk of dementia during a 9-year follow-up (Zhou et al., 2018). Our results may have important implications for the design and efficacy of cognitive interventions focused on augmenting one's social engagement to help reduce the likelihood of dementia and promote cognitive health.

The current study offers the first empirical pursuit of personality moderation of intervention effects from a conversation-based protocol. We build on previous work demonstrating ways in which personality traits modify intervention effects and maximize protocol adherence in older adults (e.g., Finkel & Yesavage, 1989; Gratzinger et al., 1990; Stine-Morrow et al., 2014). For example, levels of openness are important to consider when designing an intellectually and socially complex engagement protocol because individuals with higher openness exhibit larger increases in divergent thinking (Stine-Morrow et al., 2014). Further, interventions incorporating mnemonic techniques to enhance recall may benefit from targeting individuals high in openness because of their enthusiastic interest in learning (Finkel & Yesavage, 1989; Gratzinger et al., 1990). Openness may not be an essential consideration, however, when designing a conversational protocol. For conversation-based intervention, our results suggest that targeting individuals high in extraversion, agreeableness, and conscientiousness may help maximize intervention effectiveness as these participants demonstrated the most improvement across 18 weeks. Further, the improvement in cognitive function was limited to category fluency and letter fluency tasks, suggesting a conversation-based protocol tailored to extraverted, agreeable, or conscientious individuals may be best utilized in efforts to augment language-based EF.

Limitations and Future Directions

Several limitations of this study should be considered. Personality trait by group interaction terms explained a significant amount of variance in select cognitive domains, but remaining unexplained variance in each outcome suggests other psychosocial factors may be relevant for understanding cognitive performance. Further, the randomized controlled trial used in the analyses was a pilot study with a relatively small sample and trial duration. Due to the small sample size and exploratory nature of this study, we used the conventional type I error rate of 0.05. A larger scale randomized controlled trial is needed to enhance the understanding of personality's role in conversation-based interventions across a larger number of older adults and longer time frame. Future research should aim to assess intervention effects annually to better harness cognitive aging trajectories.

The BFI offered a brief and reliable assessment of baseline personality traits. However, we were unable to find published norms for this measure in adults 70 years of age and older (norms are available up to age 60; Srivastava, John, Gosling, & Potter, 2003). Therefore, we had no basis for comparison of our sample's scores to the general population and suggest caution when generalizing results to other community-dwelling older adults. It is possible those who expressed interest in study participation and ultimately met inclusion criteria were more extraverted, more open, and less neurotic than other individuals in the retirement communities and senior centers who received the study information. This potential selection bias may have resulted in sample characteristics that differ from the general population (Dodge et al., 2014).

Importantly, due to the relatively small sample, we were unable to stratify by cognitive status to see if the moderation analyses differed between individuals with and without MCI. Although the current study was not powered to detect differences in the MCI sample, trends toward intervention effects in psychomotor speed for this group have been reported (Dodge et al., 2015). It is possible that a larger study powered to detect differences in personality moderation by cognitive status could show a more nuanced account of personality's role in intervention efficacy. Indeed, approximately 3%–23% of adults 60 years of age and older live with MCI (Petersen et al., 2009), with an annual rate of progression to dementia for individuals in referral clinics at approximately 10%–15% and 6%–10% for individuals in epidemiological studies (Petersen et al., 2009). Future work should explicitly study the role of personality in conversation-based interventions for individuals in this transitional state between cognitively healthy aging and dementia as it is a pivotal time to intervene to reduce the later likelihood of dementia.

Conclusion

The National Institutes of Health's emphasis on personalized medicine initiatives focus on individualizing health care based on unique patient characteristics (Hamburg & Collins, 2010). Utilizing personality traits to inform intervention designs, then, provides a low-cost means to optimize intervention efficacy in older adults (Hill & Payne, 2017). The current study suggests the adaptive role of personality traits in conversation-based cognitive interventions may be limited to tasks incorporating a language component. The results support the need to tailor cognitive interventions according to an individual's personality characteristics to maximize the effectiveness of intervention and efficiency of resource allocation.

Supplementary Material

Supplementary data are available at *The Gerontologist* online.

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Conflict of Interest

None reported.

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