The Efficacy of InSight Cognitive Training to Improve Useful Field of View Performance: A Brief Report

Jerri D. Edwards,1 Elise G. Valdés,1 Carol Peronto,1 Melissa Castora-Binkley,1 Jessie Alwerdt,1 Ross Andel,1 and Jennifer J. Lister2

1School of Aging Studies and 2Department of Communication Sciences and Disorders, University of South Florida, Tampa.

Objective. It is well established that cognitive speed of processing training (SOPT) improves Useful Field of View (UFOV) performance and transfers to enhanced performance of instrumental activities of daily living, including driving. InSight is a recently developed version of SOPT formatted for self-administration by older adults with exercises translated into a gaming format. The goal was to examine whether InSight training improves UFOV performance.

Method. Participants ranged in age between 59–95 years and were randomized to InSight cognitive training or a control condition. Cognitive performance and self-perceptions were measured pre- and post-training, or for controls, after an equivalent delay. Participants completed training twice a week over a 12-week period with the goal of completing 20 sessions.

Results. Participants randomized to InSight training experienced greater improvements in their UFOV performance relative to the control condition, $F(1, 58) = 4.26, p = .043$, but no changes in cognitive self-perceptions were found.

Conclusions. The InSight program is a viable tool for enhancing older adults’ UFOV performance. Future research should examine if training gains from the program endure and transfer to improved everyday function.

Key Words: Cognitive intervention—Cognitive speed of processing training—Useful Field of View.

Numerous cognitive interventions have been developed to abate age-related cognitive declines. Systematic reviews of cognitive training research (e.g., Lustig, Shah, Seidler, & Reuter-Lorenz, 2009; Rabipour & Raz, 2012; Reijnders, van Heugten, & van Boxtel, 2013) conclude that such interventions improve the tasks trained (e.g., memory, executive function, and attention), but transfer to untrained tasks and improved everyday function is rare. One exception is cognitive speed of processing training (SOPT), which not only enhances the cognitive abilities trained (Useful Field of View Test [UFOV]; Ball et al., 2002; Edwards et al., 2005b; Roenker et al., 2003; Wadley et al., 2006) but also transfers to improved everyday function (Ball et al., 2010; Edwards et al., 2002; Edwards et al., 2005b; Roenker et al., 2003). We examined the efficacy of a new self-administered version of SOPT to improve UFOV performance in older adults.

The UFOV measures the speed at which one can rapidly process visual stimuli (Edwards et al., 2005a) and predicts older adults’ performance of instrumental activities of daily living (IADL) including driving (Ball et al., 2006; Gross, Rebok, Unverzaght, Willis, & Brandt, 2011; Roenker et al., 2003). Accordingly, studies using SOPT have demonstrated transfer to untrained everyday functions including improved IADL performance (Edwards et al., 2002; Edwards et al., 2005b), safer on-road driving performance (Roenker et al., 2003), prolonged driving mobility (Edwards, Delahunt, & Mahncke, 2009), and reduced crash rates (Ball et al., 2010). Like other cognitive intervention approaches, SOPT has not improved performance in untrained cognitive domains assessed by traditional neuropsychological measures (e.g., Ball et al., 2002; Edwards et al., 2002; Edwards et al., 2005b). However, SOPT results in longitudinal health and psychological benefits, such as improved locus of control, protection against depression, and better health ratings over 3–5 years (e.g., Wolinsky et al., 2010; Wolinsky et al., 2009). Therefore, implementing SOPT widely is of interest.

Prior versions of SOPT were trainer administered in the lab, limiting dissemination. A new computer version of the program, InSight (InSight is a registered trademark of Posit Science, Inc.), was designed for older adults to self-administer at home (Delahunt et al., 2008), given that the majority of older adults use home computers and their use is rapidly increasing (e.g., Wagner, Hassanein, & Head, 2010). Our goal was to examine whether InSight produces improvements in older adults’ UFOV performance.

The InSight version of SOPT was designed to be self-administered by older adults, and the exercises are presented in a game-like paradigm to promote engagement. The updated version includes five games aimed at improving visual and cognitive processing (see Table 1). To our knowledge, there are three published studies on InSight. One study examined only the sweep seeker exercise (see Table 1) and found improvements in visual memory and neurophysiological changes indicating more efficient visual processing, but did not examine UFOV performance (Berry et al., 2010). The other study focused only on the road tour exercise of the InSight program (i.e., the...
exercise most similar to SOPT) and found improved cognitive performance across multiple measures including UFOV (Wolinsky, Vander Weg, Howren, Jones, & Dotson, 2013). Finally, Barnes and colleagues (2013), examined a combined condition of InSight training with another cognitive program (Brain Fitness) and physical exercise. Only UFOV performance showed significant pre- to post-training gains. We investigated the effects of the entire InSight training program (as the product is marketed) on UFOV performance and self-rated cognitive abilities. Many cognitive interventions commercially available and marketed to older adults have not been experimentally tested. This study examines the efficacy of an intervention available on the market, a recognized research need (King & Suzman, 2009; Rabipour & Raz, 2012). This study is also the first to examine self-rated cognitive abilities subsequent to SOPT. It is important to examine if the translation of SOPT to a gaming paradigm is effective given prior results that other training games are not effective (Owen et al., 2010) and have not enhanced UFOV (van Mujden, Band, & Hommel, 2012). It was expected that participants randomized to InSight would demonstrate improved UFOV performance from pre- to post-training compared with controls.

**METHOD**

**Participants**

Participants aged 55 and older were recruited from newspaper articles and advertisements, as well as within retirement communities in the Tampa Bay, Florida area. Exclusion criteria, which were based upon prior SOPT studies (Ball et al., 2002), were Mini-Mental State Examination (MMSE) score less than 23 (Folstein, Folstein, & McHugh, 1975), and Near Visual Acuity score worse than 20/50, which was measured at 40 cm using standard procedures with a Sloan letter chart (Good-Lite, 2010). Participants were required to agree to participate in the training program twice a week.

A total of 75 participants were screened for inclusion. Two participants were excluded due to low MMSE scores and six participants refused after baseline (see Figure 1). The enrolled sample ($n = 67$) included 69% women and ranged from 59 to 95 years of age ($M = 73.99$, $SD = 7.48$). Most participants were Caucasian (95%), education ranged from 12 to 20 years ($M = 16.01$, $SD = 2.24$), and the sample had average MMSE scores of 28.03 ($SD = 1.80$).

**Measures**

Speed of processing for visual attention tasks was measured with the UFOV (Edwards et al., 2005a). As previously described, this reliable ($r = .74–.81$ test–retest reliability) and valid measure is the primary outcome for SOPT (Edwards et al., 2005a). The test determines the minimum display duration at which participants can process information for increasingly difficult subtests (Edwards et al., 2005a). Display times are manipulated between 16 and 500 ms to determine the 75% correct threshold. In subtest 1, a silhouette of either a car or a truck presented inside of a fixation box must be identified. Subtest 2 requires the participant to identify a car or truck presented in a fixation box and localize a car presented in the periphery. Subtest 3 requires the same two responses but includes distractors surrounding the peripheral car. Subtest 4 is just like 3, except the central task requires discriminating whether two targets [car(s) and/or truck(s)] are the same or different.

Perception of cognitive abilities was measured with the Cognitive Self-Report Questionnaire (CSRQ; Smith et al., 2009). Participants were asked to rate 25 statements about their thinking skills and feelings over the past 2 weeks on a 5-point Likert scale (e.g., “I have lost my train of thought”). The questionnaire yields three domain scores that reflect perceptions of cognition, hearing, and social function in everyday life. A prior study demonstrated the reliability (Cronbach’s alpha = .91) and validity of this measure, and improved self-perceptions were found with an auditory cognitive training program (Smith et al., 2009).

**Procedure**

Participants provided informed consent and were screened for inclusion criteria. Eligible participants were administered the UFOV and CSRQ and randomized to either immediate training ($n = 36$) or a wait list control condition ($n = 37$). Participants were retested immediately post-training (or after an equivalent delay). The controls were telephoned halfway through the wait period, thanked

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Targeted ability</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Sweep seeker</td>
<td>Visual processing</td>
<td>Identify order of visual sweeps; finer and faster sweeps</td>
</tr>
<tr>
<td>Bird safari</td>
<td>Visual target identification</td>
<td>Visual discrimination of peripheral targets; degrading visual conditions and increasing speed of presentation</td>
</tr>
<tr>
<td>Jewel diver</td>
<td>Visual tracking speed and memory</td>
<td>Track and remember visual targets; increasing number, speed, and background complexity</td>
</tr>
<tr>
<td>Road tour</td>
<td>Visual attention</td>
<td>Discriminate center target and locate peripheral target; increasing speed and background complexity</td>
</tr>
<tr>
<td>Master gardener</td>
<td>Visual speed and memory</td>
<td>Detect and remember targets; increasing speed and background complexity</td>
</tr>
</tbody>
</table>
for their continued commitment to the study, and offered training after the post-test visit.

Training participants self-administered InSight in a computer lab. The InSight program is a process-based intervention (Lustig et al., 2009) involving practice of visual/cognitive exercises aimed to improve processing speed and integrity (See Table 1). During training, participants completed InSight exercises per the program’s predetermined schedule, with tasks, difficulty, and display speed adaptive to individual performance. Training sessions were 1 hr in duration as in prior SOPT studies (Ball et al., 2002). Participants attended training 2–3 times a week for 10–12 weeks, with the goal of completing 20 sessions. Twenty sessions of training were chosen (instead of 10 as in prior SOPT studies) based on pilot testing showing that, when self-administering, participants required more time to navigate through the menus (Delahunt et al., 2008).

RESULTS

Figure 1 details study attrition (n = 13). Six participants refused after baseline, six participants refused during training, and one participant died during the course of the study. Rates of attrition did not significantly differ between the two randomized conditions, \( \chi^2(N = 73) = 2.50, p = .113 \). Logistic regression analyses were used to examine predictors (age, gender, race, education, MMSE, or training condition) of attrition (completed study or dropped out). Results indicated that only age was a significant predictor of attrition (p = .01). Participants of older age were more likely to drop out of the study.

The InSight condition participants completed an average of 15 hr of training exercises (SD = 3), with a range of 7–19 hr. Of this training time, on average 7 hr was spent on the road tour exercise (SD = 3) with a range of 1–11 hr.

Multivariate analyses examined baseline differences between the experimental (n = 27) and control (n = 33)
conditions based on age, MMSE, education, UFOV, or CSRQ. There were no significant differences between the groups at baseline, Wilk’s Λ = .953, F(5,54) < 1, p = .749 (see Table 2).

A 2 × 2 mixed ANOVA was conducted to examine the effect of InSight training (experimental vs. control group) on UFOV scores across time (pre- to post-training). Results indicated a significant main effect of time, Wilks’ Λ = .483, F(1,58) = 62.14, p < .001, η² = .517, and a significant training group by time interaction, Wilks’ Λ = .932, F(1,58) = 4.26, p = .043, η² = .068. Participants in the InSight training group showed significantly greater UFOV improvements from pre- to post-training than controls (See Table 2).

A 2 (group) × 2 (time) × 3 (CSRQ subscale) mixed ANOVA examined the effects of training on CSRQ, but there was no significant effect of time, Wilks’ Λ = .880, F(3,55) = 2.49, p = .07, η² = .12, and no group by time interaction, Wilks’ Λ = .944, F(3,55) = 1.08, p = .36, η² = .06. There were no differences from pre- to post-training between conditions in cognitive self-perceptions. One person was missing baseline CSRQ data and was not included in these analyses.

**Discussion**

InSight is a new version of SOPT developed with the goals of enabling participants to self-administer training and to make training more engaging by translating exercises into games. The results of this study indicate that InSight training improves UFOV performance, as has been previously observed with pilot versions of SOPT (Ball et al., 2002; Edwards et al., 2005b). The results of six prior studies of SOPT compared with control conditions demonstrated effect sizes (d) ranging from 0.63 to 2.5 on UFOV pre- to post-training (Ball, Edwards, & Ross, 2007). Our observed effect size of 1.5 hr (on average) of InSight training was d = 0.63, which is at the lower end of this range. This is not surprising given that the original SOPT exercises are much more similar to the UFOV test stimuli than the InSight training exercises. Other recent studies have found similar UFOV effect sizes with 9–13 hr of only the road tour training exercise (ds = 0.32–0.58; Wolinsky et al., 2013) and 18 hr of InSight training combined with 18 hr of a different training program and physical exercise (e.g., Brain Fitness, average effect size across UFOV subtests d = 0.57; Barnes et al., 2013). This evidence, paired with recent studies indicating that older adults experience UFOV improvements when completing InSight training at home (Edwards et al., 2013a) and rate the program as very engaging (Belchior & Marsiske, 2012), indicate that InSight is a successful translation of SOPT.

Although InSight significantly improved UFOV performance, participants’ self-perceptions of cognition, as indicated by the CSRQ, were not affected by training. Because this process-based training technique is procedural rather than declarative (Lustig et al., 2009; Wolinsky et al., 2010), SOPT-related improvements may not be noticed by participants. It could also be that the InSight program did not adequately provide participants with clear feedback on performance (e.g., improved threshold speeds). Future versions of the program should incorporate more feedback. Importantly, George and Whitehouse (2011) emphasize that participants’ self-ratings are not necessarily accurate reflections of cognitive training benefits. Better measures to gauge participants’ self-perceptions of cognitive training gains may be needed.

The underlying mechanisms of SOPT gains and transfer, or of cognitive interventions in general, are not yet clear. It has been hypothesized that cognitive training may enhance dopamine release in the brain (Bäckman, Lindenberger, Li, & Nyberg, 2010). According to the adult cognitive plasticity model by Lövdén and colleagues (2010), InSight may be effective because adaptive exercises maintain a mismatch between ability and task demand, a technique likely to induce plasticity and cognitive gains. Potential mechanisms of training transfer are enhanced divided attention and improved allocation of attention. Enhanced allocation

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**Table 2. Descriptive Characteristics by Condition (N = 60)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>InSight training (n = 27)</th>
<th>Controls (n = 33)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Post-training</td>
</tr>
<tr>
<td>Age (y)</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Education (y)</td>
<td>16.04</td>
<td>2.21</td>
</tr>
<tr>
<td>Mini-Mental State Exam (score/30)</td>
<td>28.37</td>
<td>1.57</td>
</tr>
<tr>
<td>Near Visual Acuity (LogMAR)</td>
<td>0.08</td>
<td>0.16</td>
</tr>
<tr>
<td>Useful Field of View Test (total ms/2000)</td>
<td>746.33</td>
<td>312.44</td>
</tr>
<tr>
<td>Cognitive Self-Report Questionnaire</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social function (score/50)</td>
<td>18.31</td>
<td>5.80</td>
</tr>
<tr>
<td>Cognitive function (score/50)</td>
<td>24.69</td>
<td>5.67</td>
</tr>
<tr>
<td>Hearing function (score/20)</td>
<td>10.96</td>
<td>4.10</td>
</tr>
</tbody>
</table>

**Note.** Cognitive Self-Report Questionnaire n for training condition is 26.
of attention, as measured by event related potentials, has been shown subsequent to InSight training (O’Brien et al., in press). This is further validated by a recent study demonstrating that impaired UFOV performance is due to disengagement of attention (Cosman, Lees, Lee, Rizzo, & Vecera, 2012). Recent mediation analyses examined the underlying mechanisms of SOPT transfer to improved IADL performance and demonstrated that the program was effective by enhancing divided attention (Edwards, Ruva, O’Brien, Haley, & Lister, 2013b). Similarly, other cognitive interventions (e.g., dual task training) targeting divided attention have transferred to improved everyday function (e.g., Li et al., 2010). Thus, improving divided attention may be a key component to obtaining training transfer. A limitation of this study is that potential mechanisms were not examined. Further research is needed to delineate the underlying mechanisms of effective cognitive training.

Another potential limitation of this study was the use of a no-contact group, rather than an active control group. However, no pre- to post-test differences on UFOV were previously found between social- and computer-contact and no-contact control conditions (Wadley et al., 2006), or between memory training and no-contact control groups (Ball et al., 2002). Furthermore, SOPT is effective in comparison to video games (Belchior et al., 2013). Thus, cognitive stimulation is not likely to enhance UFOV performance, and inclusion of an active control condition would not likely have altered our conclusions. Attrition rates were somewhat high but did not significantly differ by condition. Furthermore, the randomized training conditions were equivalent at baseline. Participants of older age were more likely to drop out of the study. Prior research shows that older age is associated with greater gains from SOPT, so this attrition may have restricted the observed effect sizes (Ball et al., 2007). On the other hand, not including participants who were lost to follow-up in analyses may have biased our findings toward the alternative hypothesis. These concerns are lessened by the fact that recent studies using intent-to-treat analyses have reported improved UFOV performance subsequent to training (Barnes et al., 2013; Wolinsky et al., 2013). This study was also limited in outcomes examined. Further research with larger and more ethnically diverse samples should test transfer of InSight training to determine if improvements in other cognitive domains and everyday functioning are derived. In sum, these results indicate that older adults randomized to InSight training show significantly larger improvements in UFOV performance compared with a control group, suggesting that the InSight training program is a viable tool to improve older adults’ UFOV performance.

Conflict of Interest
Dr. Jerri Edwards worked as a limited consultant to Posit Science, Inc. (who owns and markets the InSight training program) from June to August 2008.

Correspondence
Correspondence should be addressed to Jerri D. Edwards, PhD, School of Aging Studies, University of South Florida, 4202 E. Fowler Ave, Tampa, FL 33620. E-mail: jedwards1@usf.edu

References


