Computer-Based Cognitive Training for Individuals With Intellectual and Developmental Disabilities: Pilot Study

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Abstract

Background: There is a growing focus in the United States on preserving cognitive functioning. However, individuals with intellectual and developmental disabilities (ID/DD) are not provided with opportunities to prevent cognitive decline. To investigate whether participants with ID/DD would improve in cognitive function after cognitive training, a cognitive training group (N = 11) was compared to 2 control groups, a computer games group (N = 11) and a waitlist group (N = 10) on performance on 15 cognitive functions. Findings: (1) Very high adherence rates (94%) of the sample and 100% of the cognitive training group indicate that when given adequate individual support, adults with ID/DD can successfully use a cognitive stimulation program. (2) No significant between- or within-group effects were observed for cognitive training when a stringent a, corrected for multiple comparisons, was used. (3) Trends of improvement in cognitive function were observed for the cognitive training group.

Keywords
computerized cognitive stimulation for intellectually disabled, CogniFit, intellectual disabilities and cognitive training programs, intellectual disabilities and cognitive training, computer training

Intellectual disability (ID) and developmental disability (DD) represent widespread and heterogeneous conditions, principally characterized by cognitive deficits and difficulty with adaptive functioning in relation to the normal population.1,2 The prevalence of any type of ID/DD has been reported to be 1.078 million persons3 making up approximately 5% of the US elementary and secondary school populations. Prevalence data specific to adults experiencing ID/DD are difficult to find in the professional/treatment literature. The United States Census Bureau identified that in 2010 that 3.9 million or 1.6% of the adult population reported experiencing learning disability, 1.2 million adults (0.5%) had an ID (mental retardation), and 944 000 (0.4%) adults experienced other DDs, such as cerebral palsy or autism.4

There is a growing focus in the United States on wellness promotion and disease prevention. Individuals without ID/DD are encouraged to care for their cognitive abilities by eating right, preventing head injuries, and by exercising their bodies and brains.1 The use of computer-based programs has fast become an avenue for health promotion, especially cognition-focused interventions, and a new area of research. Although having the same or greater risk of cognitive decline,5 individuals with ID/DD are not provided with the same type or amount of health information or opportunities to exercise their cognitive abilities.6,7 Adults with DD are often overlooked and are thought not able to use a computer.8 Thus, questions existed as to whether or not adults with ID/DD would be able to use computer-based cognitive stimulation programs, would activities to exercise cognitive abilities actually be beneficial, and which type of mental/cognitive exercise program may be helpful.

A search was carried out utilizing Medline, OT Seeker, American Association on Intellectual and Developmental Disabilities, Intellectual and Developmental Disabilities journals, PubMed, and PsycARTICLES databases (without publication year limitation). Scant literature was present related to the use

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of “adult, ordinary-life” computer applications (e-mail, Internet, writing letters, vocational skills, etc)\textsuperscript{12,13} and augmentative communication\textsuperscript{12} with the ID/DD population. However, no published sources focused on computer-based cognitive skills training with the adult population of individuals with ID/DD could be found.

The literature search revealed that the existing studies employing computer-based cognitive training programs centered on the older population without a diagnosis of clinically significant cognitive impairment. This literature has shown that computer-assisted technology can assist adults to improve cognitive skills. Because of the noted lack of studies on computer-based cognitive interventions with the ID/DD population, the findings of the studies with the older population were reviewed to glean the insights that helped to formulate the current study applying a computer-based strategy with adult ID/DD individuals in a way not yet published in the literature.

A study with mild cognitively impaired individuals indicated that intensive computer-based mental activity training merited further study based on encouraging but not statistically significant results.\textsuperscript{14} Smith et al\textsuperscript{14} investigated the efficacy of a novel brain plasticity-based computerized cognitive training program in adults, noting that the experimental program improved generalized measures of memory and attention more than an active control program. In another project, investigators looked at the effects of computer-assisted cognitive training on aging-associated memory deficits, information-processing speed, learning, and interference tendency in the elderly population. The results suggested that computers could be employed to prevent and treat cognitive deficits in older people.\textsuperscript{15} Other studies have suggested that cognitive training can result in cognitive gains in healthy older adults.\textsuperscript{16,17} In Peretz et al’s\textsuperscript{18} investigation of whether personalized computerized cognitive training provides greater benefits than those obtained by playing conventional computer games, the results indicated that computerized cognitive training appeared to be better than games. The existing positive findings on computer-based cognitive training programs to provide cognitive stimulation in the nonimpaired elderly population begged the question as to whether or not such an intervention could also be useful as a health promotion strategy for the adult ID/DD population in terms of improving cognitive abilities.

The present study aimed to investigate whether adults with ID/DD might benefit from a computer-based cognitive training program and to compare any possible changes in cognitive function occasioned by cognitive training to possible changes generated by playing conventional computer games or engaging in one’s routine daily activities.

Methods

Participants

The study was conducted at a rehabilitation workshop for the ID/DD population in a medium-sized city in Northeastern Pennsylvania. Volunteers were recruited from among 145 individuals with ID/DD employed at the workshop. Study inclusion criteria were willingness to attend the program, a diagnosis of ID/DD, general good health, aged 21 or older, and being a paid employee at the Workshop. All 145 workshop attendees met the inclusion criteria with the exception of the criterion, willingness to participate. Reasons given for lack of willingness to attend were some had no interest, some noted they did not want to participate, and others indicated dislike for computers. No specific trends were noted for a lack of willingness to participate. Exclusion criteria included lack of interest in working with a computer, inability to sit at a computer for 25 to 30 minutes, and inability to see images clearly on a computer screen.

Volunteers who met the inclusion criteria were provided with an explanation of the study goals and requirements. Thirty-three volunteers indicated willingness to participate. The volunteers and their parents or guardians signed consent forms. Permission for the study was granted by the institutional review board of Misericordia University.

Procedures

Design. This was a randomized, blind, and intervention study. Participants were randomly assigned to 1 of the 3 groups: a computer-based cognitive training group, a computer games control group, or a waitlist control group. Recruited participants were assigned a number from 1 to 33 and assigned to 1 of the 3 groups. The first number pulled was assigned to the waitlist control group (who would be given the opportunity to experience the cognitive training once the study was completed); the second number was assigned to the computer games control group; and the third number to the cognitive training group. This process was repeated until all 33 participants had been assigned. Participants in the cognitive training group and the computer games control groups, but not investigators, were blind to group assignment. To preserve blindness, the games used by the computer games control group were designed to look and feel like the cognitive training treatment program. The duration of the training sessions, the online graphics, fonts, opening screens, baseline evaluation, and post-training evaluations were identical in both the programs.

Intelligence testing. To determine overall level of intellectual ability each participant was evaluated using the Test of Nonverbal Intelligence, Third Edition (TONI-3). The TONI-3 is a language-free measure of abstract problem-solving ability. It may be used with examinees from 6 through 89 years of age and is designed to be as free as possible of linguistic, motoric, and cultural factors. The test includes 2, 45-item parallel forms. It provides 1 composite score, assessing level of nonverbal intellectual development, primarily fluid intelligence, abstract reasoning, and problem solving. Average score for males is identified as 99, and average score for females is 101. The reported mean score for the mental handicap borders the diagnostic cutoff of 70. Norms were derived from a sample of 3451 individuals chosen to reflect the US population. Interrater reliability was reported to be high (.99). Test–retest reliability coefficients ranged from 0.89 to 0.94.\textsuperscript{19}
Cognitive neuropsychological evaluation. All participants were tested using the computer-based CogniFit Neuropsychological Examination to assess cognitive function at the beginning and at the end of the study. This mainstream cognitive evaluation was designed by cognitive psychologists to evaluate cognitive function at different points in time. The tasks in the evaluation bear no resemblance to the tasks used for training purposes. To prevent learning effects, tasks are equipped with item generators that assign different items or task versions on different testing occasions. The evaluation has been validated in younger adults (mean age 23 years) against several major, standardized neuropsychological tests, including the full Cambridge Neuropsychological Test Automated Battery, Raven’s Standard Progressive Matrices, the Wisconsin Card Sorting Test, the Continuous Performance Test, and the STROOP test.20 The reliability and validity of the CogniFit neuropsychological evaluation (https://www.cognifit.com) have been demonstrated in a study of older adults (aged 50 years and older), with an internal consistency of .70 (Cronbach’s), and a test–retest reliability of .80 (intraclass correlation coefficient).20

The evaluation is composed of 15 tasks that measure 15 cognitive abilities (Divided Attention, Eye-Hand Coordination, Inhibition, Monitoring, Naming, Planning, Response Time, Recognition, Shifting, Spatial Perception, Updating, Visual Memory, Visual Perception, Visual Scanning, and Working Memory). Scores on the 15 abilities are assigned using weights previously derived from a factor analysis performed on normative data from a healthy population (n = 861). Those scores are then standardized into Z scores.

Interventions. The cognitive training and computer games interventions were delivered at the workshop, each intervention in a room separate from the workshop. Both interventions were supervised by student volunteers from an accredited, degree-granting institution in northeastern Pennsylvania in baccalaureate majors of social work, psychology, or gerontology. The student volunteers were trained by one of the researchers on how to administer the computer programs. Both interventions lasted 10 weeks and consisted of 3 weekly sessions, each 20 to 30 minutes long.

1. The cognitive training intervention

CogniFit, a personalized, interactive-adaptive, computer-based, online cognitive training program which has been validated in several populations,18,21-26 was selected for this study. The version used for the present study offered training on multiple cognitive domains. It consisted of 21 different training tasks each with 3 levels of difficulty (easy, moderate, and difficult). Each training session included a mixture of visual, auditory, and cross-modality tasks designed to train a wide range of cognitive processes. Personalization of learning was accomplished by using the baseline neurocognitive evaluation, the results of which determine the individual content and level of subsequent training for each participant. During training, personalization is maintained by an adaptive feature that continually measures the patients’ performance, adapts the difficulty level of the training tasks, and provides detailed graphic and verbal performance feedback during and after each training task. Because the training regimen is designed based on the results on the neurocognitive evaluation and because the program continually adapts to each person’s strengths and weaknesses, it is unlikely that 2 participants can receive the same training regimen as regards choice of training tasks, amount, and intensity of training on each cognitive domain.

2. The computer games intervention

The computer games used by the first control group were also designed by CogniFit specifically for this study. This computer games program was designed to act as a placebo. To preserve blindness, the games outwardly resembled the cognitive training program. For example: the duration of the training sessions, the online graphics, fonts, opening screens, baseline evaluation, and posttraining evaluations were identical in both the computer games program and the cognitive training program. The games were engineered to remove salient sources of complexity but nevertheless allow some degree of training. For example, the tasks required only repetitive actions, performed one at a time. Instructions never required the player to be rapid or to attend to more than 2 stimuli simultaneously.

3. Regular daily activities

The waitlist control group continued with their usual schedule and activities. For most participants in the group, the daily routine consisted of the time spent working at the workshop, eating lunch in a common dining room, taking morning and afternoon breaks, and being transported to and from the workshop program.

Analytical Methods

SPSS 17 software was used for statistical analyses. Mixed effects models (with both fixed and random effects) for repeated measures were used to evaluate differences in the 15 cognitive variables within and between groups, a separate model being established for each variable. In the mixed effects model, the dependent variable was the cognitive outcome measure (the cognitive function) and the independent (fixed) variables were time (before or after training), group (cognitive training computer games and waitlist), and the interaction time. The patient was the random variable in the model. In the mixed models analysis, 60 between-group and within-group comparisons (15 between-group repeated measures and 45 t-tests, one for each cognitive function, for each of the study groups) were conducted. Therefore, by dividing the accepted α (.05) by 60 comparisons, a more stringent significance level, corrected for multiple comparisons, was calculated to be .000833. When rounded to 3 digits after the decimal point, this corrected α is .001. One-way analysis of variance was used to compare the 3 groups at the onset of the study on age and chi-square tests compared groups on gender, handedness, and color blindness at baseline.
Results

In the waitlist group, 1 participant passed away before pret-
est and another left for medical reasons during training so
that 31 (93.9%) of the 33 recruited patients completed the
study. Complete data were available for the 31 patients who
completed the study and partial data (pretest data) for 1
patient. These complete and partial data from 32 partici-
pants were used in the ensuing analyses. In addition to basic
demographic information such as gender, age, and educa-
tion, more specific information on handedness (which is
related to individual differences in cognition and color
blindness, which may impair performance on the neurocog-
nitive evaluation in tasks such as variants of the Stroop
task) was collected. All patients attended school until 22
years of age. As identified by the TONI 3 results, the parti-
cipants intellectually were mentally handicapped (mean
\(\bar{x} = 68.7\), standard deviation [SD] 6.03; range
\(\bar{x} = 60-84\)). There
were no significant differences among participants with
respect to demographic data. The sample consisted of 25
male and 8 female caucasians. Table 1 provides demo-
graphic information.

Table 1. Personal Attributes of the Study Training and Control Participants at Baseline.

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Mean</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td>Age in years</td>
<td>44.18</td>
<td>10.51</td>
<td>37.27</td>
<td>11.21</td>
</tr>
<tr>
<td>Gender (female)</td>
<td>4</td>
<td>36.4</td>
<td>2</td>
<td>18.2</td>
</tr>
<tr>
<td>Handedness (left hand)</td>
<td>3</td>
<td>27.3</td>
<td>1</td>
<td>9.1</td>
</tr>
<tr>
<td>Color blindness (yes)</td>
<td>1</td>
<td>9.1</td>
<td>2</td>
<td>18.2</td>
</tr>
</tbody>
</table>

Abbreviation: sig, significance.

Table 2. Mixed Models Statistics for Baseline Differences on 15 Cognitive Abilities for the 3 Study Groups.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Cognitive Training Group Baseline, Mean (SD) N = 11</th>
<th>Placebo Computer Games Group Baseline, Mean (SD) N = 11</th>
<th>Waitlist Control Group Baseline, Mean (SD) N = 10</th>
<th>(F) Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA</td>
<td>−1.84 (1.05)</td>
<td>−2.12 (0.63)</td>
<td>−2.22 (0.90)</td>
<td>0.4 (2, 58.68)</td>
</tr>
<tr>
<td>EH</td>
<td>−3.25 (3.53)</td>
<td>−3.83 (2.31)</td>
<td>−2.82 (0.60)</td>
<td>0.35 (2, 44.38)</td>
</tr>
<tr>
<td>IN</td>
<td>−3.57 (2.60)</td>
<td>−4.40 (2.54)</td>
<td>−3.81 (2.44)</td>
<td>0.41 (2, 57.13)</td>
</tr>
<tr>
<td>MN</td>
<td>−2.97 (1.81)</td>
<td>−2.79 (1.33)</td>
<td>−3.14 (1.55)</td>
<td>0.15 (2, 44.40)</td>
</tr>
<tr>
<td>NM</td>
<td>−3.15 (2.20)</td>
<td>−3.07 (1.78)</td>
<td>−3.18 (2.50)</td>
<td>0.01 (2, 43.37)</td>
</tr>
<tr>
<td>PL</td>
<td>−3.30 (1.72)</td>
<td>−2.90 (1.84)</td>
<td>−2.76 (1.68)</td>
<td>0.33 (2, 43.09)</td>
</tr>
<tr>
<td>RC</td>
<td>−3.64 (1.18)</td>
<td>−3.74 (0.92)</td>
<td>−3.78 (0.78)</td>
<td>0.06 (2, 56.17)</td>
</tr>
<tr>
<td>RT</td>
<td>−2.61 (2.49)</td>
<td>−2.31 (2.64)</td>
<td>−2.27 (2.26)</td>
<td>0.1 (2, 35.33)</td>
</tr>
<tr>
<td>SH</td>
<td>−2.39 (1.76)</td>
<td>−3.00 (1.85)</td>
<td>−2.18 (1.24)</td>
<td>0.04 (2, 49.84)</td>
</tr>
<tr>
<td>SP</td>
<td>−4.87 (4.56)</td>
<td>−4.55 (3.08)</td>
<td>−4.19 (4.09)</td>
<td>0.12 (2, 56.68)</td>
</tr>
<tr>
<td>UP</td>
<td>−3.05 (1.77)</td>
<td>−3.17 (1.70)</td>
<td>−3.32 (1.77)</td>
<td>0.08 (2, 40.97)</td>
</tr>
<tr>
<td>VM</td>
<td>−9.20 (5.42)</td>
<td>−8.15 (3.56)</td>
<td>−8.96 (4.90)</td>
<td>0.19 (2, 43.02)</td>
</tr>
<tr>
<td>VP</td>
<td>−3.83 (2.34)</td>
<td>−3.75 (1.61)</td>
<td>−3.87 (2.12)</td>
<td>0.01 (2, 45.50)</td>
</tr>
<tr>
<td>VS</td>
<td>−3.07 (3.01)</td>
<td>−3.52 (3.05)</td>
<td>−2.35 (2.44)</td>
<td>0.57 (2, 46.44)</td>
</tr>
<tr>
<td>WM</td>
<td>−0.6 (0.98)</td>
<td>−0.47 (1.04)</td>
<td>−0.75 (1.25)</td>
<td>0.2 (2, 43.98)</td>
</tr>
</tbody>
</table>

Abbreviations: DA, Divided Attention; EH, Hand-eye co-ordination; IN, Inhibition; MN, Monitoring; NM, Naming; PL, Planning; RC, recognition; RT, Response Time; SH, Shifting; SP, Spatial Perception; UP, Updating; VM, Visual Working Memory; VP, Visual Perception; VS, Visual Scanning; WM, Working Linguistic-Auditory Memory; SD, standard deviation.

Results

In the waitlist group, 1 participant passed away before pret-
est and another left for medical reasons during training so
that 31 (93.9%) of the 33 recruited patients completed the
study. Complete data were available for the 31 patients who
completed the study and partial data (pretest data) for 1
patient. These complete and partial data from 32 partici-
pants were used in the ensuing analyses. In addition to basic
demographic information such as gender, age, and educa-
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were no significant differences among participants with
respect to demographic data. The sample consisted of 25
male and 8 female caucasians. Table 1 provides demo-
graphic information.
Attention, Inhibition, Recognition, and Updating in the computer games group (Table 3, column 7) and Monitoring, Response Time, Updation, and Working Memory in the wait-list group (Table 3, column 10). Those effects, observed within the groups, and most notably within the cognitive training group, when using lenient significance levels, are of special interest in such seminal proof-of-concept studies, especially when so small a sample is used and so unique a population is considered.

Effect size was also examined via Cohen’s d computations. Cohen-d effect size sets a benchmark of 0.20 as small, 0.50 as medium, and 0.80 as large. Calculations were based on the differences between posttest and pretest mean scores first for the cognitive training group and then for the computer games group. In the cognitive training computer group, Monitoring, Planning, Recognition, Response Time, Shifting, Spatial perception, Visual Memory, and Visual Scanning showed medium-sized effects (Cohen’s d ranged from .58 to .72) and Naming, Visual Perception, and Working Memory showed small effect sizes (Cohen’s d = .44, .37, and .41, respectively). In the computer games group, Divided Attention showed a large-sized effect (Cohen’s d = .85); Inhibition and Recognition showed medium-sized effects (Cohen’s d = .67 and .64, respectively) and Updating a small-sized effect (Cohen’s d = .44). In the waitlist group, Updating and Working Memory showed medium-sized effects (Cohen’s d = .56 and .54, respectively) and Response Time showed a small-sized effect (Cohen’s d = .40).
Discussion

The project’s aim was to determine whether the use of a cognitive training program might enhance cognitive performance of individuals with ID/DD. As reported, none of the comparisons of cognitive functions scores between the groups (computer-based cognitive intervention group, computer games group, and wait-list control group) reached statistical significance. This could be due to the small number of participants in each group.

The within-groups comparisons did yield encouraging findings, especially with regard to the cognitive training group. Of the 15 measured, 11 cognitive abilities trended toward improvement using lenient statistical significance criteria. This is congruent with other studies. Simpson et al. found significant improvement in simple reaction and task reaction time in a study of a 21-day online computer-based cognitive training intervention administered to 34 individuals aged between 53 and 75 years. Using computerized cognitive training exercises targeting attention, processing speed, visual memory and executive function, Finn and McDonald found that the 16 participants with mild cognitive impairment improved performance across a range of tasks. Likewise, Van der Molen et al. found a significant increase in visuospatial working memory capacity in individuals with mild to borderline IDs as a result of focused computer program activities.

In the current study, several other cognitive abilities showed movement toward improvements at more lenient p levels ranging from .003 to .098. Although not significant at the stringent p level set for this study, these positive changes are important in view of the unique needs of this population. Similarly, when Cohen’s d was computed, most of the statistical effects were of medium size (7 effects) or small size (4 additional effects). These novel results should be viewed as trending toward the idea that cognitive function might be enhanced in intellectually disabled populations via cognitive stimulation-focused, computer-based programming. Longer trials with larger populations might add further clarity to the current findings.

The computer games group showed 4 effects (1 large, 1 medium, and 2 small), while the waitlist showed 3 effects (2 medium and 1 small). As noted earlier, the computer games designed for the computer games group lacked complexity. Yet, student volunteers reported that individuals in this group seemed to have more fun than individuals in the cognitive training group. It is possible that the low levels of complexity purposefully assigned to these games, and described previously, were particularly suitable for this population. In future research, it is suggested that webcam videoing be incorporated to capture the qualitative aspects of participant responses.

Since the computer games participants trended toward improvements in the skills of divided attention, inhibition and recognition, and updating, it would be beneficial to study the effect of low complexity computer game playing on individuals with ID/DD who are not able to sustain attention in more challenging, structured cognitive training programs. These conceptually based cognitive skills are noted to be an area of difficulty for individuals with ID/DD. Perhaps long-term use of such programs would offer cognitive benefit. Although not reaching significance, the waitlist control group also experienced advances in updating and working memory. It is possible that these changes were the result of test–retest bias as memory is clearly a factor in this type of bias.

Important insights have emerged from this study. Of the 33 recruited patients, 31 (93.9%) completed the study. This very high adherence rate is consistent with findings of studies, which demonstrate that individuals with ID/DD will use, when encouraged or assisted to do so, computer programs that are “not childish,” not too difficult, and help users grow in some manner. Through keen observations, student volunteers were able to make subtle adaptations and utilize a very gentle and supportive approach that proved successful in engaging the participants. These adherence results are doubly impressive with consideration of the fact that these computer-based training activities proved safe for individuals with ID and DD. Prior to giving consent, caregivers had been alerted that individuals with ID/DD do not cope well with change or new demands. From informal observation, we can report that cognitive training and the computer games were not overly frustrating and did not encourage stress-induced acting out of negative behaviors. Although it had been a concern, no acting out behavior, crying, sleep problems, or exacerbation of previous dysfunctional behavior were evident.

The findings of the current study support the idea that computer-aided instruction can increase motivation, attention, and time on task by presenting instruction in an interactive medium with features such as sound, animation, and video recordings. Similarly, Bunning et al. found that basic engagement and attention levels appeared to increase over the course of their study of computer-based activities with individuals having IDs. In another project, it was suggested that students with mild IDs could successfully acquire problem-solving skills with computer-assisted technology. The findings of the current study are in accord with the results of these 3 studies indicating that populations with ID and DD can successfully utilize computer programs to achieve a variety of cognitive enhancements.

This is believed to be the first experimental study in which a computer-based cognitive training program was tested with adults experiencing ID/DD who were randomized into an intervention group or 1 of the 2 control groups. This study has yielded important insights and lessons for the better design of cognitive training for individuals with ID/DD. Strengths of the study also included the observational and adaptive skills of the student volunteers who assisted the participant with any issues during the study. For instance, some participants had difficulty working the mouse due to motor skill issues. When they wanted to left click they would often simultaneously right click and display the computer’s settings menu. To eliminate the problem, the student therapist disabled the mouse’s right button with a small piece of cardboard and also highlighted the left mouse button with a sticker to encourage use of that key instead.
Limitations of the Study
A limitation of this study was the small sample (n = 33) comprised of adults with ID/DD from 1 organization. Additionally, previous research indicated that individuals with ID are already utilizing sophisticated technologies, including computers (41%), video games (37%), cell phones (28%), and the Internet (25%). It was assumed, perhaps erroneously, that participants had limited or no experience with computers/technology; however, further background information on each participant’s engagement with computer technology, particularly in the 12 months preceding the study, would have provided relevant data to examine this aspect of the findings.

The donated computer equipment was dated. Although mouse pads were helpful, the old mouses with the interior rolling ball were an issue. Perhaps several participants could have done better with touch screens. Although each participant worked on his or her own computer, all participants in the group were in the intervention room at the same time. What role group presence had on performance is unknown. Likewise, the impact of the student volunteers’ support needs further investigation. Questions remain regarding the influence of the level of assistance provided and the impact of verbal/nonverbal cuing. Again, use of video recording may capture these qualitative features to determine the effect each may have on the results obtained. There was no opportunity to consistently collect functional data on the activities of daily living over the 10-week intervention time period. Thus, there may have been unidentified confounding variables that impacted the findings. Future research should also attempt to compare cognitive gain to functional performance (eg, was there any associated improvement in workshop performance?).

Conclusion
This study, developed to test the use of a computer-based personalized cognitive training program, demonstrated highly encouraging results. First, with proper support and supervision, 100% of the adults with ID/DD in the computer-based activities completed the cognitive training program and the computer games program. Second, despite the very small sample (N = 11), a clear trend for cognitive improvement was observed in the cognitive training group. A phase II study could seek to determine what, if any, qualitative dynamics such as intrinsic factors, motivation, and so on are at work as was the case with the individual who stated “it makes me think.” Hoppestad noted “once formal schooling is over, there appears to be scant interest in supporting adults using computers.” The results of the study were encouraging as to the potential of the adult population with ID/DD if only given the opportunity to improve their cognitive functioning. The availability and relatively reasonable price of online cognitive training programs also enables caregivers to readily utilize this approach to stimulate their loved ones’ cognitive ability. The findings of this study suggest that with equipment properly adapted to the individual, computer-based cognitive stimulation programs can be beneficial for adults with ID/DD. Our research suggests that improvement appears possible in those individuals with limited cognitive abilities.

Declaration of Conflicting Interests
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