Preservation of Learning Abilities in People with Dementia and Depression with Different Levels of Cognitive Impairment

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Background

Data regarding learning potential in people with dementia are very limited (1, 2). Recent findings indicate that improving mitochondrial function has positive effects on the learning capacities in animal models of Alzheimer's studies (3, 4, 5).We hypothesize that people with mild to moderate dementia have preserved learning capacities.

Objective

To investigate the learning potential for different targets (flowers, numbers and words) in people with dementia and depression.

Subjects / Methods

The subjects were 32 medically ill patients (19 women, 13 men) with different levels of dementia with depression (age - 79.32 ± 7.15; education - 13.41 ± 3.43). They ranged in age from 70 to 95 years.

After the subjects completed an informed consent about the procedures, they were evaluated by using the Mini Mental Status Examination (MMSE) (6), and an original, computerized, continuous visual learning task. Three types of visual stimuli were used: flowers, double digit numbers and three letter words. The exclusion criteria for this protocol were poor task comprehension and inability to finish all three types of visual stimuli in one session.

The task is designed to present one type of stimuli (6 targets) on the screen simultaneously for about 20 seconds. The subjects then make a two-choice decision for each stimulus. The subjects view 6 previously presented stimuli and 6 foils, and make an old/new judgment by pressing one of two keys.

The task has three parts. The first is the continuous visual learning part of the task (or learning curve) that consists of several trials of the same type of stimuli (flowers, numbers and words), until the person reached his or her maximum learning capacity. The second part is a 5 minute break with music and pictures of nature. The third part involves recall/recognition of previously memorized targets.

Performance (number of correct answers) and intrusions (numbers of mistakes) were assessed on every trial and in the 5 minute recall. All analyses were conducted using the Statistical Package for Social Sciences(SPSS) 16.0 (SPSS Inc, Chicago, IL). Data analysis included descriptive statistics, Wilcoxon Signed-Rank test, and Spearman correlations. Two-tailed tests were performed for all analyses and *p* was set to 0.05.

Results

MMSE scores were 25.22 ± 4.80, ranging from 18 to 30. Table 1 shows data for main descriptive statistics. There was no correlation between MMSE score and rest of the data.

Table 1. Descriptive statistics

Targets	Flowers (F)		Numbers (N)		Words (W)		p value		
	Mean	SD	Mean	SD	Mean	SD	F-N	F-W	N-W
Trial 1 Correct	3.88	1.43	3.66	1.38	4.34	1.62	0.443	0.148	0.050
Trial 1 Intrusion	1.53	1.16	1.31	1.03	0.78	0.91	0.417	0.008	0.022
Maximum numbers of t	3.19	1.40	3.63	1.34	2.63	1.68	0.206	0.069	0.008
Trial Max Correct	5.59	0.87	5.53	0.80	5.75	0.57	0.586	0.527	0.235
5-min recall correct	5.16	1.17	4.69	1.49	4.53	1.32	0.165	0.027	0.454
5-min recall intrusion	1.16	1.14	0.97	1.09	0.91	1.23	0.446	0.201	0.630

Trial 1 Correct - the numbers of memorized targets after first trail
Trial 1 Intrusion - the numbers of intrusions after first trail
Max numbers of trails - the amount of steps to achieve max results
Trial Max Correct - the numbers of max memorized target
5-min recall correct-the number of memorized targets after 5 minutes break
5-min intrusions-the number of intrusions after 5 minutes break

There were two observed learning patterns: 1. A gradual increase in the number of correct answers with every subsequent trial ("good" attention, Figure 1) and 2. A fluctuation in the number of right answers ("poor" attention, Figure 2) on each consequent trial.

Figure 1. "Good" Attention

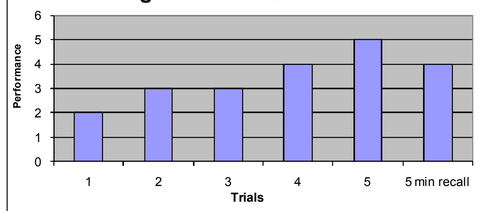
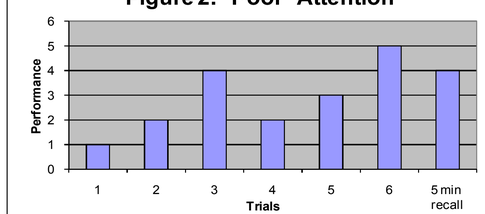
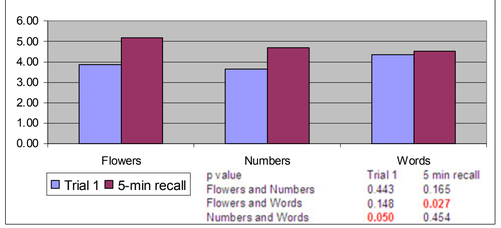


Figure 2. "Poor" Attention



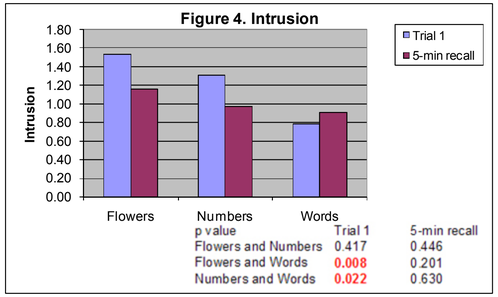
Performance on immediate recall was higher on words, then followed by flowers (p>0.05) and numbers (p<0.05). Performance on 5 minute recognition was higher for flowers, follow by numbers (p>0.05) and words (p<0.05) (Figure 3).

Figure 3. Performance



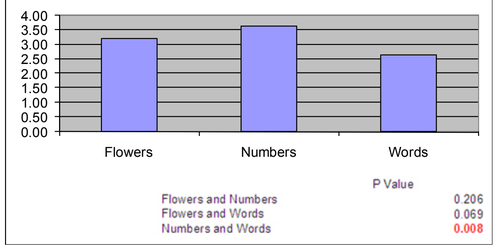
On immediate recall, the number of intrusions was lowest on words, followed by numbers (p<0.05) and flowers (p<0.05). On five minute recognition, the number of intrusions was lowest on words, followed by numbers (p>0.05) and flowers (p>0.05) (Figure 4).

Figure 4. Intrusion



The amount of trials to achieve maximum results was lowest for words, followed by flowers (p>0.05) and numbers (p<0.05) (Figure 5).

Figure 5. Maximum numbers of trails



For flowers and words, the positive correlations were demonstrated between correct answers on the first trial, 5 minute recall and maximum memorized targets, and the negative correlations were found between the numbers of trials to achieve learning capacity and all correct answers (Table 2).

Table 2. Correlations between performances and max numbers of trials.

Flowers	T1	MNT	TMC
Trial 1 correct (T1)	1.000		
Max numbers of trials (MNT)	-0.526		
p value	0.002		
Trial Max Correct (TMC)	0.434	-0.642	
p value	0.013	0.001	
5 min recall (5R)	0.424	-0.439	0.683
p value	0.015	0.012	0.001
Numbers	T1	MNT	TMC
Trial 1 correct (T1)	1.000		
Max numbers of trials (MNT)	-0.441		
p value	0.011		
Trial Max Correct (TMC)	0.334	-0.435	
p value	0.061	0.013	
5 min recall (5R)	0.230	-0.312	0.701
p value	0.206	0.082	0.001
Words	T1	MNT	TMC
Trial 1 correct (T1)	1.000		
Max numbers of trials (MNT)	-0.864		
p value	0.001		
Trial Max Correct (TMC)	0.458	-0.614	
p value	0.008	0.001	
5 min recall (5R)	0.380	-0.389	0.413
p value	0.032	0.028	0.019

For numbers, the positive correlation was only between maximum memorized targets and 5 minute recall and negative correlations were between the number of trials needed to achieve learning capacity and correct answers on the first trial and on maximum memorized targets.

Discussion

We designed the computerized, continuous visual learning task for different types and different amounts of visual stimuli. The more challenging objective in designing this task was to develop a measurable, dynamic mechanism that could be used easily for testing and training learning processes in people with mild to moderate dementia. The design of this program was intended for people with physical limitations such as decreased motor speed and visual accuracy. Only two buttons on the keyboard were used for this task. The time for test administration ranged from 15 to 20 minutes, and the continuous visual learning task was well-tolerated by this group of patients.

The first and second training sessions are the baseline for initial individual assessment and for development of the training protocol. The goals of the training were explained to participants regarding their learning abilities and the use of different targets. After the first session, the results of the training were demonstrated to participants, and feedback was provided about all learning patterns.

The participants demonstrated learning capacity for each of the three types of stimuli. People have their own unique learning profile for every type of stimuli. The preservation of learning capacities in people with dementia were confirmed on different types of stimuli (pictures of cats, dogs and children – data collection in progress). These presented data related only to words, numbers and flowers. The limitation of this study is that the participants were in the treatment protocol for different periods of time (from one month to several years).

The selected types of presented stimuli were related to different target representation in the brain: words – in the left, verbal hemisphere, and flowers and numbers – in the right, nonverbal hemisphere or in both hemispheres (7, 8).

Two patterns of learning were observed in this study: one with "good" attention and the other with "poor" attention. Individuals with "good" attention demonstrated a progressive increase in performance with each subsequent trial, while individuals with "poor" attention had lapses in performance with subsequent trials.

During the learning period of the test, people learned words better and faster, with less numbers of intrusions, compared with learning flowers or numbers. The progressively increasing performance during the learning part of the task demonstrated activation of attention and working memory networks for various types of visual stimuli in people with dementia. In our previous study, we demonstrated that people with mild to moderate dementia with depression are still capable to perform fairly well on n-back 2 task on different targets (words, numbers, pictures, textures and shapes)(9).

After a 5 minute break, flower targets had better recall/recognition performance than words. These findings need further investigation.

Conclusion

We have demonstrated that people with different levels of cognitive impairment have preserved their learning abilities. The results of this paradigm set the stage for future investigations of learning potentials and cognitive rehabilitation in dementia.

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