Poster P2-420

N-back Task to Tailor Memory Training Protocols for People with Dementia and Depression Based on Working Memory Profile.

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Background

The N-back task is a common tool in cognitive neuroscience that has been used extensively in functional neuroimaging studies to investigate the neural networks of working memory (1). It has been shown that different visual spatial stimuli activate the pre-frontal cortex in varying locations (2).

However, there are no data related to using the N-back task in people with depression and dementia, especially for the development of individualized memory training protocols.

Objective

To determine the working memory profile for different visual stimuli (words, numbers, shapes, pictures and textures) based on N-back paradigm for people with depression, and concomitant depression and dementia.

Subject/Methods

70 medically ill patients (males and females), 32 with depression only (group 1: age = 73.5± 5.78, education = 13.9±2.79) and 38 with mild to moderate dementia with depression (group 2: age = 75.7±6.51, education = 12.9±3.65), were assessed for working memory profile (words, numbers, shapes, etc.) by an originally designed, computerized, visual-spatial N-back task.

The patients received information about the testing procedures and signed an informed consent form. The patients were evaluated by MMSE, the MADRAS depression questionnaire and the computerized N-Back 2 task.

The N-back task program was designed to be used by people with physical limitations, including decreased motor speed and visual acuity. Only 2 buttons on a keyboard were used for this task. The presented N-back 2 task was well tolerated by these groups of patients.

The subjects were asked to monitor the identity of a series of different stimuli presented in a sequence. They had to push one of two possible buttons ("yes" or "no") with the index finger of their dominant hand to indicate whether the currently presented stimulus was one that had been presented in previous n-trials. The stimuli were displayed for 800 ms, with an inter-stimuli interval of 800 ms. In each block there was a warm up period trial which was not analyzed. During the testing trials, target stimuli (same stimulus as n-trials before) were presented randomly with a probability of 30%.

The different stimuli for the N-back task include the following: two-syllable words, three-digit numbers, simple shapes, pictures of people in actions, and textures. The stimuli were presented in 5 blocks, each block consisting of only 1 type of stimulus (words, or numbers, or shapes and so on). The same sequence of blocks was presented for each individual.

The number of stimuli trials per block was 40. Targets (set to be approximately 30% of total signals) were presented for a second time for recognition.

Reaction time (RT), performance (recognized targets x 100/total target) and errors ([missed targets + false positive targets] x 100/total stimuli) were obtained for each block. The percentage of correct answers, the percentage of errors and mean response times were computed. Data analysis included descriptive statistics, T-tests, and Spearman correlations.

Results

MMSE scores ranged from 19 to 30. MADRS score was consistent with mild to moderate depression in both groups (group 1: 18.72±9.10, group 2: 19.95±7.86).

Mean reaction time ranged from 1039 ms to 1504 ms (Table 1). There were no significant differences in the reaction time between the two groups. The fastest reaction time was N-back textures in both groups (group 1: 1039 ms, group 2: 1199 ms). The slowest reaction time was N-back numbers, in both groups as well (1503 ms, 1504 ms respectfully). Reaction times for N-back shapes and N-back words in Group 2 had a tendency to be longer than in Group 1.

Table 1: N-back task: Reaction time

	Group 1		Group 2	
	Mean	SD	Mean	SD
Textures	1039.09	395.37	1198.73	519.07
Numbers	1503.13	664.47	1504.58	668.14
People	1132.78	228.33	1270.73	640.26
Shapes	1191.13	353.34	1339.47	806.59
Words	1197.31	280.03	1399.79	882.31

Performance (percentage of correct responses) ranged from .62 (textures) to .89 (words) (Performance Graph bellow). Performance on N-back for words was highest in both groups (group 1: .89±.12, group 2: .79 ±.22). The worst performance was found to be for textures in both groups (.62±.24 and .65±.23). Performance on N-back for words in group 1 was significantly higher than in group 2 (.89 ± .12 and .79 ± .22, p<.033 respectfully). The same significant difference was seen between groups in the N-back task for numbers (.82 ± .24 and .70 ± .23, p <.011 respectfully).

Errors ranged from .06 (words) to .26 (shapes and numbers) (Table 3). The least number of errors was found in both groups on N-back for words. The number of errors in group 1 (.06) for words and numbers was significantly lower than in group 2 (.13).

The number of significant correlations in performance in group 1 were less, compared with group 2 (Table 4). The same findings were observed regarding the numbers of errors (Table 5).

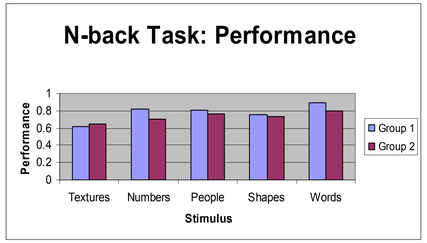

Table 3: N-back task: Errors

	Group 1		Group 2		
	Mean	SD	Mean	SD	P
Textures	0.23	0.11	0.22	0.10	0.333
Numbers	0.21	0.11	0.26	0.10	0.033
People	0.10	0.08	0.15	0.16	0.087
Shapes	0.24	0.13	0.26	0.13	0.315
Words	0.06	0.06	0.13	0.17	0.031

Table 4: Performance

Variable 1	Variable 2	Correlation	P
Group 1 Depression			
Shapes	Texture	0.450	0.010
Words	People	0.386	0.029
Group 2 Depression and Dementia			
People	Textures	0.355	0.031
Shapes	Textures	0.380	0.020
Shapes	Numbers	0.470	0.003
Shapes	People	0.489	0.002
Words	Numbers	0.443	0.005
Words	Shapes	0.412	0.010

Table 5: Errors

Variable 1	Variable 2	Correlation	P
Group 1 - Depression			
Shapes	People	0.447	0.010
Words	People	0.464	0.007
Words	Shapes	0.417	0.018
Group 2 - Depression and Dementia			
People	Texture	0.411	0.012
Shapes	Texture	0.533	0.001
Shapes	Numbers	0.461	0.004
Shapes	People	0.442	0.006
Words	Texture	0.501	0.002
Words	Numbers	0.435	0.006
Words	People	0.455	0.005
Words	Shapes	0.525	0.001

Discussion

We designed the computerized N-back task for computer naïve people with physical limitations. The working memory of five types of visual stimuli (words, shapes, numbers, people and textures) was assessed in 2 groups (group 1 – depression and group 2 – depression with dementia). Many brain structures and physiological processes are involved during working memory tasks (3).

The types of stimuli we selected were based on differing hemisphere involvement during the N-back task. Information containing images related to letters is activated by the verbal hemisphere. Information containing images related to texture is activated by both hemispheres (4). The data presented here demonstrates that activation of working memory networks is different for various types of visual stimuli. People with depression and early dementia are still capable to perform fairly well on N-back 2 task.

Differences in the reaction times indicate that the time for response generation was the most difficult for three digits numbers (1500 ms) in both groups. Between the groups, the reaction time tended to be shorter only in group 1 for words, shapes, people and texture. Probably, these visual tasks were easier to perform for people in group 1 (depression only).

Performances and errors indicate differences in network involvements during these tasks. In the group 2 (depression and dementia), the highest performance on words was surprising and needs to be investigated further. The results of this paradigm help us to determine the initial targets for computerized and non-computerized memory training. Individual memory training protocols were designed, with an emphasis on words, people and shapes (for both groups) and numbers (for group 1). The N-back paradigm is a promising tool for the non-invasive investigation of working memory profiles that can aid in designing cognitive rehabilitation protocols for people with depression and dementia.

In 2000 we checked the working memory profile of a small group of people by using software (Cognometer) with N-back paradigm subtests (5). Two-year integrative treatment with computerized memory training showed an improvement in attention, memory and executive function in patients with depression and moderate dementia (6).

The computerized memory training in this small group of depressed, cognitive impaired elderly patients (n=10) had a positive impact on reaction time (Cognometer data) and other tests related to different cognitive domains, such as attention (Ruff 2&7 Selective Attention) and frontal lobe functioning (Ruff Right Frontal Fluency) (7).

Conclusion

We have demonstrated the feasibility of using N-back task for prompt assessment of working memory profiles in people with cognitive deficit.

We believe that the results of this paradigm are useful for the development of individual memory training protocols for people with depression and dementia.

References

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