Online Cognitive Training Improves Cognitive Performance

Bernard Croisile [1,2], Diana Miner [3], Sandrine Bélier [2], Michel Noir [2], Franck Tarpin-Bernard [2]

[1] Centre Mémoire de Ressources et de Recherche de Lyon, Neuropsychology laboratory, Cognitive Functions, Language and Memory – Neurological Hospital of Lyon, France.
[2] Scientific Brain Training, 66 boulevard Niels Bohr, F-69100 Villeurbanne, France, [3] HAPPYneuron Inc. Mountain View, CA, USA

ABSTRACT

Description: In late adulthood, cognitive functioning gradually declines with age, a process most people wish to prevent. Several studies of healthy individuals have found that training can improve cognitive performance in several areas of mental functioning. This study demonstrates that loss of cognitive function is not inevitable with age. Specifically this study demonstrates that, regardless of age, gender and educational level, the summary scores of 85 healthy adult participants significantly increased across five major cognitive domains following 18 weeks of intensive online cognitive training.

INTRODUCTION

- In late adulthood, cognitive functioning gradually declines with age, a process most people wish to prevent.
- A meta-analysis showed that memory performance in healthy older adults improved with training exercises (Verhaeghen, 1992).
- Further, studies have also showed that a cognitively stimulating life-style significantly impacts personal cognitive well-being (Hultsch, 1999; Wilson, 2003).
- The ACTIVE study (Ball, 2002) showed that cognitive training considerably improved memory, processing speed and reasoning. Most improvements were maintained at 5-year follow-up (Willis, 2006), and the reasoning group reported significantly less difficulty in the instrumental activities of daily living after 5 years.
- Prospective and retrospective studies suggest that education and cognitively stimulating activities such as socialization and hobbies reduce the risk of Alzheimer's Disease (Fabrigoule, 1995; Stern, 1999; Friedland, 2001; Scarmeas, 2001; Wilson, 2002).
- We report the experience of the performance development of 85 regular users to a cognitive training website after carrying out 500 exercises.

METHODS

The website used provided 40 training exercises that target 5 major cognitive domains, i.e., Memory, Attention, Language, Executive Function and Visuo-Spatial skills.

- The exercises were designed by a team of neurologists, neuropsychologists and cognitive psychologists.
- They are regularly validated by 2 research groups (20 seniors) from the "Université Tous Ages" (“University for Elderly People”, Lyon 2 University, France).
- These exercises target independent, healthy persons.
- The cognitive training enables subjects to regularly perform a set of varied exercises that allow them to:
  - perform the exercises they are most interested in,
  - work on cognitive domains they judge to be weak.
- An analysis of 628 users shows a majority of women (64%), a predominant academic level (56%), and an average age of 41.8 years with 3 peaks: age 22, 44 and 57 (Croisile, 2006). 9% of all 628 users are over 70 years.

Online exercises

- Each exercise consists of 3 parts:
  - an educational "Example";
  - "Know more", an explanation of neuropsychological relevance;
  - the "Exercise" itself.
- Options: Three difficulty levels (easy, medium, hard) and several thematic variants
- Accuracy and Time scores are standardized by age, gender and educational level (percentile).
- “Advice and Commentary” section offers training recommendations.

The Virtual Coach

- Various cognitive parameters from each exercise contribute to combined scores for memory, attention, language, executive function and visuo-spatial skills.
- Taking into account the value of exercise-related cognitive indicators, a computer supervisor tracks the subject's performances. As the user continues training, other indicators will be updated (deduced performances from achieved scores).
- Users are free to choose their training exercises.
- At each logon, however, the computer supervisor offers each subject four exercises. The goal is to avoid routine and to stimulate training variety. Users are free to start one or more exercises in whichever order they wish.
- The supervisor also suggests a variant and a level of difficulty for each exercise.

METHODS (cont.)

The Selection Process

- All 85 users were chosen according to the following criteria:
  - over age 20,
  - training period longer than a month,
  - at least 5% of exercises in each cognitive domain,
  - no more than 50% of exercises in one domain.
- In order to skip the stage of initial familiarization with the program, the performance of the 85 users were analyzed from the 75th (T75) to the 500th (T500) exercise.

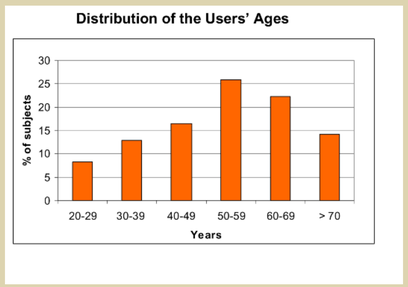
Exercise Examples

These are examples of games in the program.

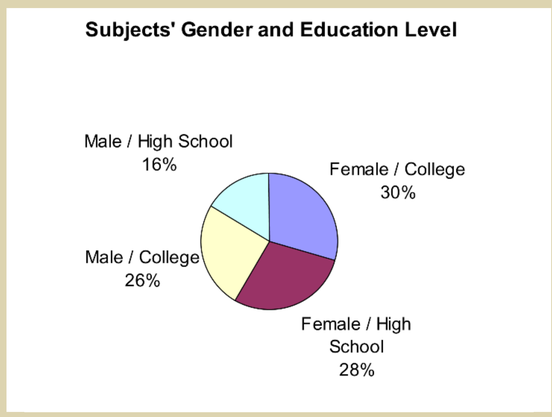
- Bird Songs: Visual Spatial Skills - This game challenges the subject to develop a memorization strategy to distinguish the name, appearance and songs of different birds.
- Basketball in New York: Executive Function – This is a problem-solving exercise. It consists of mentally calculating the necessary moves for successful outcome. It trains mental calculation skills.
- Split Words: Language Skills - This exercise helps the subject to practice quickly retrieving words from his or her verbal repertoire, avoiding the ‘tip of the tongue’ responses.
- Shapes and Colors: Memory Skills - This exercise calls upon visual short-term memory.

Demographics of Subjects

- Average age of the 85 subjects is 53.5 years ± 14.8 (range, 23-81 years)
- 36.5% of subjects are over 60 years and 14.2% over 70 years, thus, exercises are suitable for seniors.

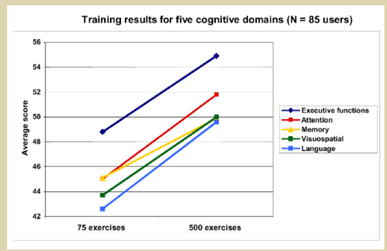


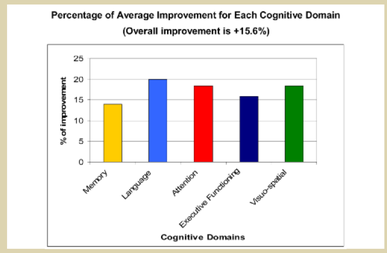
- Subjects include a majority of women (58%).
- College graduates predominate (55%), more so for men (61%) than women (51%).



RESULTS

- At T75, the score for Executive Functioning is significantly higher than the other 4 scores [F (4,420) = 3.44, p = 0.009, post hoc Fischer test].
- Between T75 and T500, a two-way ANOVA showed a significant domain effect [F(4,420) = 3,79 p = 0.005], a significant effect of training from 75 to 500 exercises [F(4,420) = 290.4, p = 0.0001] without significant interaction [F(4,420) = 1.04, p = 0.39].
- Between T75 and T500, performance shows considerable improvement for all 5 cognitive domains (all Fischer protected t-tests significant at p < .0001).
- At T500, Executive Functioning scores remain considerably higher than Memory, Language and Visuo-spatial scores, but no higher than Attention [F(4,420) = 3.55, p < .008, post hoc Fischer test).
- In this analysis , neither age, nor gender nor education influenced performance.





DISCUSSION & CONCLUSION

- Regardless of age, gender and educational level, the scores of 85 healthy adult participants significantly increased across 5 major cognitive areas following 18 weeks of intensive cognitive training during which they carried out 425 exercises.
- All cognitive areas improved and Executive Functioning was the most improved area.
- In addition to common hobbies that afford cognitive stimulation, regular online cognitive training with games allows people to:
  - better understand their cognitive weaknesses
  - enjoy the brain training process
  - enhance their self-esteem.

REFERENCES

Ball K, Berch DB, Helmers KF, Jobe JB, Leveck MD, Marsiske M, Morris JN, Rebok GW, Smith DM, Tennstedt SL, Unverzagt FW, Willis SL, for the ACTIVE Study Group. Effects of Cognitive Training Interventions With Older Adults. A Randomized Controlled Trial. JAMA 2002; 288: 2271-2281.

Croisile B. La stimulation de mémoire. Quel rationnel? Quels exercices? Revue de Gériatrie, 2006 (juin), 31, n°6 : 421-433.

Fabrigoule C, Letenneur L, Dartigues JF, Zarrouk M, Commenges D, Barberger-Gateau P. Social and leisure activities and risk of dementia: a prospective longitudinal study. J Am Geriatr Soc 1995; 43: 485-490.

Friedland RP, Fritsch T, Smyth KA, Koss E, Lerner AJ, Chen CH, Petot GJ, Debanne SM. Patients with Alzheimer’s disease have reduced activities in midlife compared with healthy control-group members. Proc Natl Acad Sci USA 2001; 98 : 3440-3445.

Hultsch DF, Hertzog C, Small BJ, Dixon RA. Use it or lose it: engaged lifestyle as a buffer of cognitive decline in aging ? Psychol Aging. 1999 Jun; 14(2): 245-263.

Rebok GW, Rasmusson DX, Brandt J. Prospects for Computerized Memory Training in Normal Elderly: Effects of Practice on Explicit and Implicit Memory Tasks. Applied Cognitive Psychology, 1996; 10: 211-223.

Scarmeas N, Levy G, Tang MX, Manly J, Stern Y. Influence of leisure activity on the incidence of Alzheimer's disease. Neurology 2001, 57 (12) : 2236-2242.

Stern Y, Albert S, Tang MX, Tsai WY. Rate of memory decline in AD is related to education and occupation: cognitive reserve ? Neurology 1999 ; 53 (9): 1942-1947.

Verhaeghen P, Marcoen A, Goossens L. Improving memory performance in the aged through mnemonic training: A meta-analytic study. Psychology and Aging, 1992; 7: 242-251.

Willis SL, Tennstedt SL, Marsiske M, Ball K, Elias J, Koepke KM, Morris JN, Rebok GW, Unverzagt FW, Stoddard AM, Wright E; ACTIVE Study Group. Long-term effects of cognitive training on everyday functional outcomes in older adults. JAMA 2006; 296(23): 2805-2814.

Wilson RS, Mendes De Leon CF, Barnes LL, Schneider JA, Bienias JL, Evans DA, Bennett DA. Participation in Cognitively Stimulating Activities and Risk of Incident Alzheimer Disease. JAMA 2002; 287: 742-748.

Wilson RS, Barnes LL, Bennett DA. Assessment of lifetime participation in cognitively stimulating activities. Journal of Clinical and Experimental Neuropsychology 2003, 25(5): 205-213.