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Research report

Do you believe in brain training? A questionnaire about expectations of computerised cognitive training

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HIGHLIGHTS

- People tend to have high baseline expectations of brain training.
- Expectations of brain training appear to be modifiable using simple, yet direct, messages.
- Compared to young adults, older adults report greater optimism regarding brain training.
- Individual characteristics may influence expectations of brain training.

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ABSTRACT

"Brain training" (i.e., enhancing, rehabilitating, or simply maintaining cognitive function through deliberate cognitive exercise) is growing rapidly in popularity, yet remains highly controversial. Among the greatest problems in current research is the lack of a measure of participants' expectations, which can influence the degree to which they improve over training (i.e., the placebo effect). Here we created a questionnaire to measure the perceived effectiveness of brain-training software. Given the growth in advertising of these programmes, we sought to determine whether even a brief positive (or negative) message about brain training would increase (or decrease) the reported optimism of participants. We measured participants' expectations at baseline, and then following exposure to separate, brief messages that such programmes have either high or low effectiveness. Based on the knowledge they have gleaned from advertising and other real-world sources, people are relatively optimistic about brain training. However, brief messages can influence reported expectations about brain-training results: Reading a brief positive message can increase reported optimism, whereas reading a brief negative message can decrease it. Older adults appear more optimistic about brain training than young adults, especially when they report being knowledgeable about brain training and computers. These data indicate that perceptions of brain training are malleable to at least some extent, and may vary depending on age and other factors. Our questionnaire can serve as a simple, easily-incorporated tool to assess the face validity of brain training interventions and to create a covariate to account for expectations in statistical analyses.

Brain training (i.e., enhancing, rehabilitating, or simply maintaining cognitive function through deliberate cognitive exercise) has generated great hope among researchers and the public, yet also fears of hype. On the one hand, myriad studies have described significant improvement in a variety of cognitive functions (e.g., working memory (WM), speed of information processing, control of attention, and memory) following even brief periods of training in healthy young adults, older adults [1,2], children [3,4], and various clinical populations [5,6]. Improvements have been reported following many different types of intervention, ranging from targeted cognitive exercises (e.g., strategy training [7] or other unitary training modules [8]) to more integrative or holistic approaches (e.g., video games) [9]. Companies target consumers of all ages and cater to individuals across the spectrum of mental acuity with a variety of products, ranging from hi-tech products or software marketed under the rubric of "entertainment" to complex programmes designed for clinical therapy. The promise of brain training enhancing cognitive functioning has created a booming scientific field and a billion-dollar commercial industry, neither of which shows any sign of abating [10].

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On the other hand, several high-profile negative findings [11] and critiques of brain-training research methods [9,12] have tempered the enthusiasm of many researchers [13]. One major methodological limitation is insufficient experimental control [14]. Few studies, if any, have addressed the potential impact of participant expectations on brain training results (e.g., via the placebo effect), despite evidence for ubiquitous effects of expectations elsewhere [15]: In several psychiatric conditions, patients who begin with higher expectations of the effectiveness of their medications show greater improvement [16,17]. Patient expectations may even influence brain stimulation outcomes [18,19].

Little is known about expectations of brain training, but the existing evidence indicates that such expectations are important: Market surveys suggest that approximately half of those who engage in brain training believe they are achieving positive results [10]. Patterns of improvement on perceptual and cognitive tasks following action and problem-solving video game training fit with what independent observers would predict [20,21]. Furthermore, advertisements of brain training often target older adults with the promise of preventing or attenuating cognitive decline. Despite the particular importance – and promise – of brain training research in older adults [1,8,22], their levels of expectation are currently unknown. Given the influence of expectations on other intervention outcomes, and the recent surge in consumer marketing of brain training, an investigation of people's expectations of brain training seemed timely [21].

In the present study, we created a questionnaire to evaluate perceptions and expectations of brain training; for greater precision, we used the term "cognitive training" in our experimental protocol. We examined five main questions: (i) Do people tend to have neutral, optimistic, or pessimistic expectations of brain training?; (ii) Can a brief message touting (or disputing the claims of) the effectiveness of brain training lead participants to report greater (or reduced) optimism?; (iii) Are older adults particularly optimistic about brain training, relative to young adults?; (iv) Is perceived effectiveness affected by proposed frequency and dosage of training?; (v) Might any other individual characteristics be associated with higher (or lower) expectations?

We administered a web-based survey to 499 participants, including young (n = 380 [275 women]; age M = 19.84, SD = 2.58), middle-aged (n = 15 [10 women]; age M = 47.40, SD = 7.52), and older adults (n = 104 [68 women]; age M = 69.88, SD = 5.27), recruited from the community via flyers, advertisements, and word-of-mouth. We also recruited young adults from the University of Ottawa's Integrated System of Participation in Research for undergraduate students. Participants recruited from the community received no compensation for completing the survey; young adults recruited from the participant pool received minimal course credit (.5 points) for their participation, and were free to choose this study from among several alternatives. The University of Ottawa Research Ethics Board approved this study. Participants anonymously answered questions about their perceptions of the effectiveness of computerised cognitive training. We provided all participants with the same definitions of "cognitive function", "cognitive training", and "computerised cognitive training" before beginning the survey. We performed all analyses (including analyses of variance [ANOVAs] and Pearson correlations) using IBM SPSS Statistics, Inc.

1. What do people expect from brain training?

We asked participants to rate how successful they believed computerised cognitive training would be at improving their general cognitive function, on the basis of their existing knowledge. All ratings were made on a scale from 1–7 (1 = "completely unsuccessful," 2 = "fairly unsuccessful," 3 = "somewhat unsuccessful," 4 = neutral/"I have absolutely no expectations," 5 = "somewhat successful," 6 = "fairly successful," 7 = "completely successful"). The mean baseline rating of expectations was 4.89 (SD = 1.16), falling between neutral and "somewhat successful," revealing that, based on the knowledge they have gleaned from advertising and other sources in the real world, people are optimistic about "brain training." A frequency analysis concurred, showing that the majority of respondents to this question believed that cognitive training would be "somewhat", "fairly", or "completely" successful (346/499 = 69%).

2. Can a brief message touting (or disputing the claims of) the effectiveness of brain training lead participants to report greater (or reduced) optimism?

Following the baseline question, which all respondents answered solely on the basis of their pre-existing knowledge, we presented 441 of our participants with a pair of scenarios in counterbalanced order.

One scenario implied that brain training has high effectiveness (High Expectation Message; Fig. 1A), and the other implied that such programmes have low effectiveness (Low Expectation Message); see below. In an initial version (Version I; n = 89) of the survey, the Low Expectation Message was relatively mild, simply prescribing caution when considering information about cognitive training (Fig. 1B). However, because few people–especially older adults–appeared to heed the warning of the "Low Expectation" message, we altered that message to describe cognitive training in a more negative way in Version II (Fig. 1 C; n = 352). The messages and corresponding citations in both versions of the questionnaire were comparable in length, format, and reading level.

Overall, participants reported believing the High Expectation Message, with ratings indicating an increase in estimated effectiveness compared to baseline (Version I: $t_{(90)} = 3.82$, $p < 0.001$; Ms = 5.22 and 4.78, SDs = 1.10 and 1.06, respectively; Cohen's d = 0.41; Version II: $t_{(361)} = 7.11$, $p < 0.001$; Ms = 5.36 and 4.88, SDs = 1.20 and 1.17, Cohen's d = 0.41; Fig. 2). In contrast, the low expectation scenario led participants to downgrade their expectations compared to baseline (Version I: $t_{(90)} = 2.06$, $p = 0.04$; M = 4.41, SD = 1.43, Cohen's d = 0.29; Version II: $t_{(361)} = 10.18$, $p < 0.001$; M = 3.93, SD = 1.55, Cohen's d = 0.69). Simple, yet direct, written messages containing evidence advocating for or against brain training can, respectively, increase or decrease people's reported initial optimism regarding such programmes. This notion was supported in the reactions of respondents to the High and Low Expectation messages in comments made at the end of each version of the survey:

> 19-year old man: "The use of scientifically backed data in peer reviewed journals make claims by researchers much more authentic. As a result, my neutral position was swayed somewhat to either side based on the evidence. However, I am aware that the messages did not say that all studies supported their data, and the fact that some of the sample study sizes [sic] were not very large also failed to convince me wholeheartedly."

> 23-year old woman: "The messages stating that there are no findings of positive results of computer programmes used for cognitive training shifted my mindset to believe that the training was a complete waste of time and I immediately felt resigned to failure. Regardless of the actual study results, if I believe it will fail I will not attribute [sic] any real cognitive effort or my full attention to the task, the [sic] eliminating a chance for any improvement. The positive messages made me feel that the