Discuss the importance of appropriate experimental design in brain-training studies.

Simons et al (2016) discusses many aspects of a brain-training program that must be taken into account when determining whether brain-training programs are performing as expected. Here, we aim to elaborate and add to the list of important points to consider when designing a brain-training study.

First, the tasks selected to be used for brain-training must be appropriate to answer the question being asked. The tasks selected must also be validated and specific to the cognitive domain being explored. If a task has not been shown to be valid then applying it in lab and/or to emulate a real-world scenario will not allow any concrete conclusions to be drawn from the brain-training outcomes. The growing body of brain-training literature shows little consistency in the tasks used either for training or for testing of cognitive change. Some studies use established neuropsychological tests (e.g. verbal span, digit span) while others use commercially available programs designed for the explicit purpose of brain-training (e.g. Lumosity, ACTIVATE). One of the most commonly used tests is a variant on the N-back task (auditory, visual, or both) because of its well known reliance on working memory systems (Jaeggi et al 2010, Owen et al. I forget the year) (n-back validity paper)).

One can not run an experiment without participants. The expectations participants have about brain-training (either innate or induced) affects the degree to which participants improve during a brain training manipulation: participants who believe brain training works show improvement, while those who do not believe it works show no improvement (e.g. Foroughi et al, 2016, Sala & Gobet 2019) [No placebo effect – Tsai et al 2018]. One way to attempt to control for participants’ induced expectations is through using a randomized controlled and blinded trial design to explore effects. In health research, this is the gold-standard of testing and requires that both participants and experimenters are blind to the particular research questions being asked. DISCUSS WHETHER RCTS ARE ALWAYS NECESSARY TO ANSWER BRAIN TRAINING QUESTIONS AND WHEN THEY CAN NOT BE USED

The way participants are divided into groups (control vs test) can affect the conclusions that can be drawn from the results. Depending on the question being asked, an appropriate control group should be selected. As described by Simons et al (2016), in some cases an active control group may be warranted (i.e. a test group that performs a task that is as engaging as the test task, but does not activate the cognitive domains being tested) while in other cases a passive control group may be reasonable (i.e. a group that does not perform any type of demanding task during the ‘test’ phase of the experiment). ELABORATE MORE ON WHEN THE TWO TYPES (OR BOTH) CONTROL GROUPS MIGHT BE REASONABLE TO USE. Importantly, active control groups must use a reasonably equivalent task in terms of cognitive and attentional demands in order to be considered a truly active group. The equivalency between the tasks used in the test and control groups should be measured and stated.

A key aspect to any brain-training paradigm is the amount of training that participants engage in. In other words, what ‘dose’ of brain-training is required to see the desired effect. The dose of brain-training should be justified as to the why the amount was chosen and how the amount might affect participants (fatigue, etc). When possible, dosing should be similar to or based on amounts used in previous literature. However, depending on the question being asked, and the cognitive domain being explored, the dosing of brain-training can vary quite drastically from a single, one-hour training session to 20 x 30-min training sessions spread over four weeks. The variety in dosing reflects an outstanding question in the literature regarding what is the required dose to see an effect. Future studies that contrast the effects of short bursts of intense training against training programs spread out over lond periods are warranted.

One of the reasons choosing an appropriate dosing amount is important is because of the real-world applicability of the training paradigm. Many of the brain-training batteries are advertised as enhancing brain function through small amounts of training every day, however, if the literature shows that gains are only seen after hours of training a day then the feasibility of using such paradigms on a large scale are limited. Therefore, the real-world applicability of the training paradigm must be taken into account when designing a study meant to answer a question with it’s roots in a real-world problem.

OTHER STUFF

* *N-back & knowledge 20 sessions over 4 weeks (20-30min/session) = 10 hours/month– Jaeggi et al, 2014*
* *n-back 1hour – Foroughi et al (2016)*
* *n-back & knowledge 7days x 25 min/session = 3.5hours – Tsai et al (2018)*

*“We find that studies using a noncontact (passive) control group strongly favor the alternative hypothesis that training leads to transfer but that studies using active-control groups show modest evidence in favor of the null.” (Dougherty et al 2016)*

Reporting of results from brain-training studies

Results from analyses defined in pre-registration should be reported separately from any analyses that were designed after data was collected