

Note: this document may not describe the most recent version of this cognitive test available from TestMyBrain. TestMyBrain cognitive test documentation will be updated over the next several months to align with current test versions.

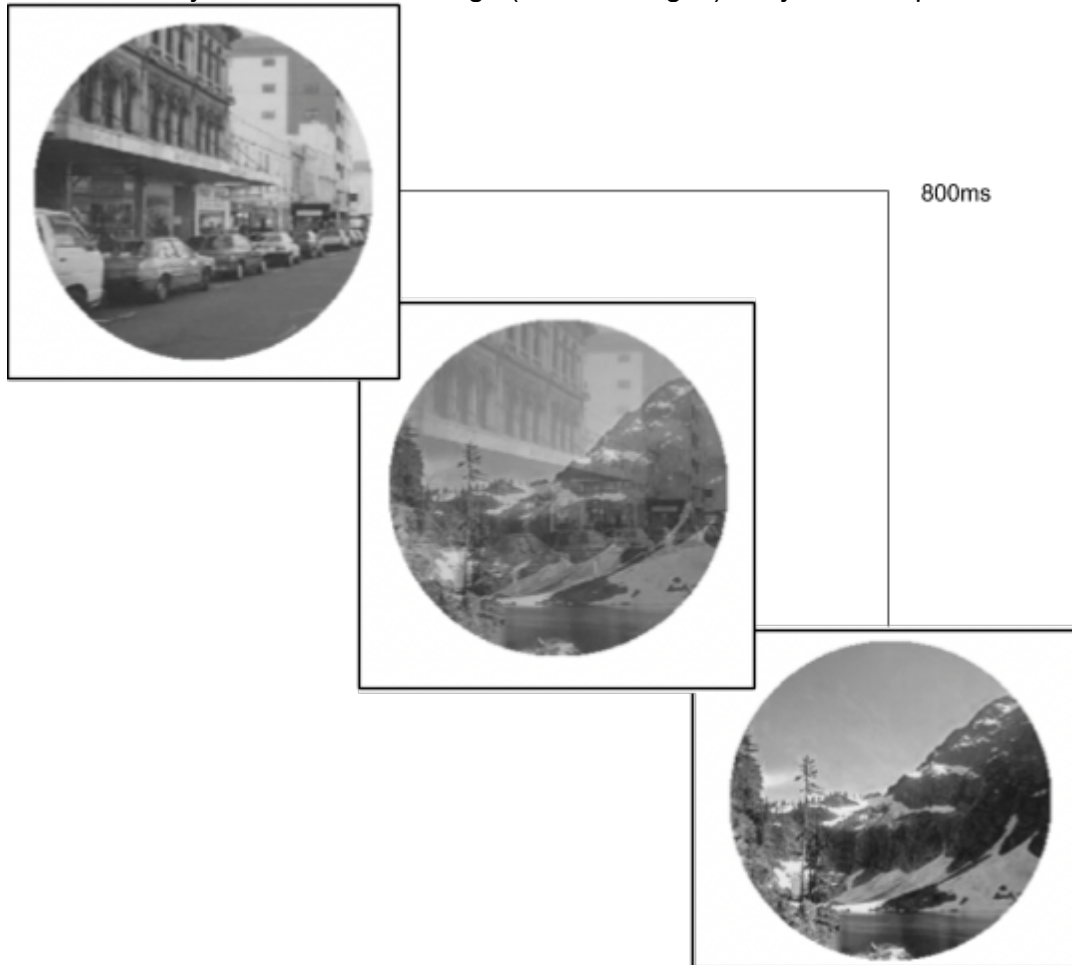
TMB Gradual Onset Continuous Performance Test

Constructs Measured: sustained attention, cognitive control, response inhibition

Duration: 6.9 minutes

Sample size for which normative data are available: 20,367

Description of procedure: In this task a person attends to images that gradually transition from one image to the next. Whenever they see a street image (90% of images), they press a button. Whenever they see a mountain image (10% of images), they *do not* press a button.



This test is a standard not-X Continuous Performance Test, combining the sustained attention component of the Continuous Performance Test with a response inhibition component similar to the standard Go-No-Go test. The difference between this test and other not-X CPT variants is that this test manipulates stimulus presentation in such a way that it rapidly exhausts attentional resources, making it very sensitive to individual differences in vigilance while also being very

brief¹, allowing reliable measures in 3-4 minutes as opposed to 15-20 minutes. In this task, participants are asked to respond to images that rapidly transition from one image to the next. Whenever they see a city scene (90% of images), they are instructed to press a button. Whenever they see a mountain scene (10% of images), they are instructed *not* to press a button. Images transition pixel-by-pixel over 800ms for a total of 4 minutes. This test was first developed by Rosenberg et al., 2013 to provide a more difficult and brief measure of sustained attention and response inhibition.

Advantages of the task include the fact that it is relatively quick and easy to administer on a range of mobile devices and the large number of trials in a short time make it amenable to sophisticated time series modeling and analysis. Disadvantages of the task are that the nature of the construct make it high burden for most participants.

Psychometric Characteristics

The gradCPT yields four useful measures of attention and cognitive control:

1. Omission errors - % of times the participant did not press a key when they saw a city image. More errors reflect poorer attention / concentration.
2. Commission errors - % of times the participant accidentally pressed a key when they saw a mountain image. More errors reflect poorer response inhibition.
3. Average response time - how quickly the person responded to city images. Faster response times reflect faster or more efficient information processing.
4. Response time variability - how much the person's response time varied over the course of the task (based on standard deviation in response times). Less variable response times are associated with more consistent performance overall and are thought to reflect the ability to maintain a controlled attentional state that is colloquially referred to as being "in the zone" (Rosenberg et al., 2013).

Measures of (1) and (2) can be combined using signal detection theory to yield a discriminability score, reflecting the person's ability to accurately discriminate city (key press) from mountain (no key press) trials, and a bias or criterion score, reflecting the person's response threshold or strategy used.

This test also has good reliability of 0.95 for average response time, 0.9 for response time variability, 0.77 for response sensitivity, and 0.78 for response bias (Esterman et al., in 2012, 2014).

Here, we will focus on commission errors (or, accuracy on no-go trials) as the primary outcome measure or score. Based on TMB data, commission errors on the GradCPT provide both sensitive (see Figure 1) and reliable (split-half reliability of 0.7) measure, particularly given that such trials only appear 10% of the time. If desired, evaluations of these other measures can be included in the final report.

Sociodemographic effects were estimated based on omission accuracy no-go accuracy (1 - commission error rate) based on a sample of 38,621 participants. The distribution of scores is relatively normal, with minor ceiling effects (see Figure 1). Performance is variable across the lifespan, with increases in performance until about age 45 and with decreases into older age (see Figure 2). Based on age adjusted scores, there is little to no gender difference (see Figure 3). Participants with higher levels of education are more accurate (see Figure 4).

There are likely some practice effects on this test, but these are not evident in our database (first-time participants, no-go accuracy = 76%; repeat participants, no-go accuracy = 75%). Data from the Aurora study will allow us to quantify practice effects in the near future.

Validation

The gradCPT was first used by Esterman et al. (2012) as an individual differences measure of sustained attention, and performance on this task has shown to be impaired in patient populations who traditionally exhibit attention problems (Auerbach et al., 2014; DeGutis et al., 2015), correlates with self-reported attention problems in everyday life (Rosenberg et al., 2013), and fluctuates based on circadian rhythms (Riley et al., 2017). This makes it a useful task for understanding both state and trait-level differences.

Within the TMB GradCPT, commission error rate is highly correlated with variability in reaction time (coefficient of variability: standard deviation in reaction time / mean reaction time; $\rho = -0.44$, $n = 1347$, 95% CIs [0.4, 0.48]). Commission errors are modestly correlated with accuracy on a Choice Reaction time test that also loads on cognitive inhibition ($\rho = 0.25$, $n = 1347$, 95% CIs [0.2, 0.3]). TMB GradCPT test performance has relatively low correlations with other distinct tests that require high effort or attention, but have a more traditional trial-by-trial structure, including the TMB Letter-Number Sequencing test ($\rho = 0.08$, $n = 2525$, 95% CIs [0.04, 0.11]) and the TMB Multiple Object Tracking test ($\rho = 0.11$, $n = 1022$, 95% CIs [0.05, 0.17]).

Appropriateness for Field Test Use

Considering the test is designed to be cognitively fatiguing, the TMB GradCPT test is relatively brief and reasonably well tolerated. Difficulties understanding the task (especially given the speed of the task), presents a potential challenge to completion, which has been addressed by including 3 x 1 minute practice phases before participants start the test. With this included, participants tend to know what they are supposed to do and there are minimal barriers to completion.

Device Effects. The TMB GradCPT test is easy to administer across a range of devices. Device characteristics are likely to impact measurements of mean reaction time, but less impactful on accuracy-based measures or measures of reaction time variability. The data show little to no effect of device type on commission error performance / accuracy (e.g. iPad mean = 70%, SD = 21%, N = 90; iPhone mean = 72%, SD = 15%, N = 106; Macintosh desktop / laptop mean = 72%, SD = 17%, N = 199).

Participant Burden. The TMB GradCPT test is considered burdensome by participants, and is less engaging than other measures. Ratings on this test (3.6 / 5 stars) are slightly lower than the TestMyBrain.org average (3.7 / 5), with low completion rates compared with the rest of site (64% TMB GradCPT vs 81% sitewide completion among consented participants).

Figure 1: Distribution of scores

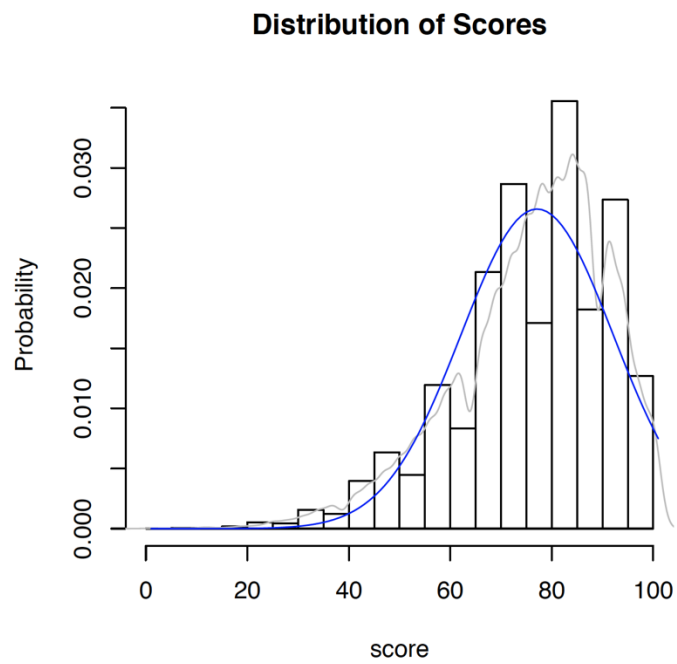


Figure 2: Age-related differences in performance

Age Differences

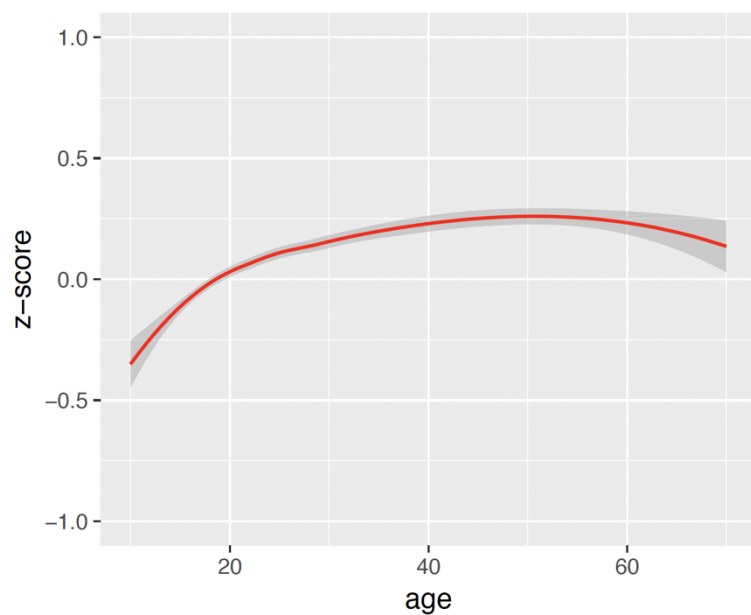


Figure 3: Sex differences in performance

Sex Differences

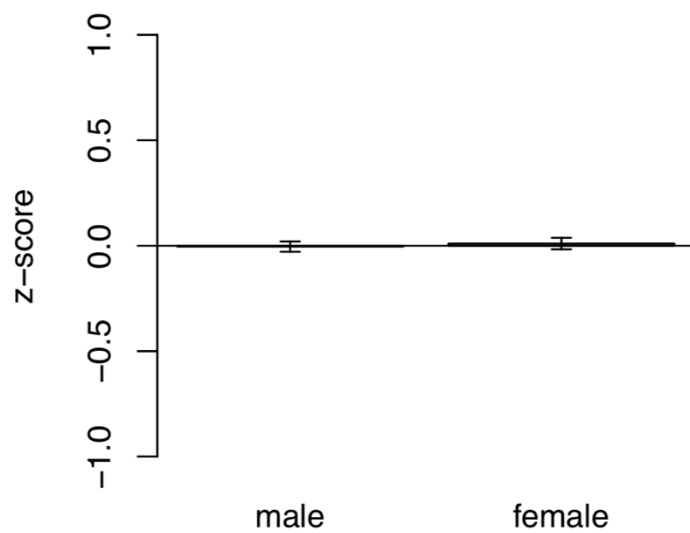


Figure 4: Education-related differences in performance

