ASSIGNMENT COVERSHEET

UNIVERSITY OF TECHNOLOGY, SYDNEY

UTS: ENGINEERING & INFORMATION TECHNOLOGY

SUBJECT NUMBER	NAME OF STUDENT(s) (PRINT CLEARLY)	STUDENT ID(s).
41079	IBRAHIM, Bishar; HAHN, Lucas; TJOKRO, Darren; PRUGER, Shaun; DESHPANDE, Kaushik (SURNAME, FIRST NAME)	13236207 13573605 13196086 13214655 12554200
SUBJECT NAME Computing Science Studio 2		

STUDENT EMAIL	STUDENT CONTACT NUMBER
lucas.m.hahn@student.uts.edu.au	0432828498

NAME OF TUTOR	TUTORIAL GROUP	DUE DATE
Joakim Skarding	Group 7.0GPAEZ	09/06/2020

ASSESSMENT ITEM NUMBER/ TITLE

ASSIGNMENT 3 - Research Paper

☑ I confirm that I have read, understood and followed the guidelines for assignment submission and presentation on page 2 of this cover sheet.

☑ I confirm that I have read, understood and followed the advice in my Subject Outline about assessment requirements.

☑ I understand that if this assignment is submitted after the due date it may incur a penalty for lateness unless I have previously had an extension of time approved and have attached the written confirmation of this extension.

Declaration of Originality: The work contained in this assignment, other than that specifically attributed to another source, is that of the author(s) and has not been previously submitted for assessment. I understand that, should this declaration be found to be false, disciplinary action could be taken and penalties imposed in accordance with University policy and rules. In the statement below, I have indicated the extent to which I have collaborated with others, whom I have named.

Statement of Collaboration:

Signature of Student(s) ____________ ______Date 09/06/2020

ASSIGNMENT RECEIPT

To be completed by the student if a receipt is required

SUBJECT NAME/NUMBER	NAME OF TUTOR

SIGNATURE OF TUTOR	RECEIVED DATE

STYLE GUIDE for ASSIGNMENT SUBMISSION

Before submitting an assignment you should refer to the policies and guidelines set out in the:

- Faculty Student Guide (https://my.feit.uts.edu.au/modules/myfeit/downloads/StudentGuide2010Spring_Online.pdf)
- UTS Library writing guidelines (www.lib.uts.edu.au/students/discover-your-library/referencing-and-writing)
- ELSSA Centre for writing support (www.elssa.uts.edu.au)
- UTS Coursework Assessment Policy (www.gsu.uts.edu.au/policies/assessment-coursework.html)

Unless your Subject Co-ordinator has indicated otherwise in your Subject Outline for each subject, you must follow the instructions below for submission of assignments in UTS: Engineering and UTS: IT.

Writing Style

It is usually best to write your initial draft in the default settings of your software without formatting. Use the following guides in your writing.

Purpose and Audience: use the correct genre and language style expected for the particular task.

Language: use "Plain English" for all technical writing. More information about this language style can be found at www.plainenglish.co.uk/free-guides.html.

Use spelling and grammar software tools to check your writing. Edit your document.

Standards: always use:

- Australian spelling standards (Macquarie Dictionary)
- SI (International System of Units) units of measurement
- ISO (International Organisation for Standardisation) for writing dates and times for international documents. For example **yyyy-mm-dd** or **hh-mm-ss**. However, for most applications it is more helpful to present the date in full as **26 August 2010**.

Graphics and Tables should:

- be numbered
- have an appropriate heading and/or caption
- be fully labeled
- be correctly referenced.

Presentation

Unless otherwise instructed, all assignment submissions should be **wordprocessed** using spell-check and grammar-check software. Work should be well **edited** before submission. Use the following default settings.

Page Setup: set margins at no less than 20mm all round.

Paper: print on A4 bond, double -spaced and preferably double-sided, left justified.

Font: use the software default style to provide consistency. The recommended style includes:

- 10 - 12 pt font
- consistent formatting with a limited number of fonts
- lines no more than 60 characters (use wider margins or columns if you need to make lines shorter)

Header: should include

- your name and student number
- the title of the paper or task.

Footer: should include the page number and current date.

Cover sheet and statement of originality: all work submitted for assessment must be the original work of the student(s) submitting the work. A standard faculty cover sheet (see over) must be attached to the front of the submission. Any collaboration between the submitting student and others must be declared on the cover sheet.

Referencing

All sources of information used in the preparation of your submission must be acknowledged using the Harvard system of referencing. This includes all print, video, electronic sources.

Phrases, sentences or paragraphs taken verbatim from a source must be in quotation marks and the source(s) cited using both **in-text** referencing and a **reference list**.

Plagiarism is the failure to acknowledge sources of information. Students should be fully aware of the meaning of plagiarism and its consequences both to your marks, position at the university and criminal liability. The plagiarism in your assignment submissions can be assessed both in hard copy and in soft copy through submission to such sites as Turnitin.

The UTS Library and the ELSSA Centre (web links listed above) both have information for students on referencing correctly to support you in avoiding plagiarism.

Assessing the Technical Validity of a Neurological Hybrid Clinical Test For Measuring Cognitive Ability

Group 7.0GPAEZ

Bishar Ibrahim (13236207)

Darren Tjokro (13573605)

Kaushik Deshpande (13196086)

Lucas Hahn (12554200)

Shaun Pruger (13214655)

Revised Project Proposal

Research Question

➔ Can we improve upon multiple aspects of cognitive abilities by combining two clinically approved tests into a single hybrid test?

Project outline

What is the project about?

- The project is about exploring whether a hybrid clinical test can improve upon existing clinical tests by designing and creating an online hybrid test in which we can measure for technical validation

- The project involves researching various clinical tests and brainstorming a new way of neurological testing and hopefully used for furthering research into cognitive abilities and health

- Our motivation for this project was to create a tool to accurately measure cognitive health and potentially aid the elderly.

Objectives

1. Conduct a comprehensive Literature review to understand the field of cognitive health and cognitive tests using games
2. Research clinical tests to be used in creating a hybrid test
3. Conclude which tests can be used to create a hybrid test and build into a game
4. Design the working functionality of the hybrid test
5. Build a working hybrid test prototype using the popular javascript framework “React”
6. Technically validate the prototype by testing against an agreed criteria
7. Analyse the resulting data to determine whether the hybrid test improves upon existing test
8. Document our analysis in a research paper

Resources

Knowledge needed for this task to be processed :

1. Programming knowledge (React/Javascript)
2. Knowledge on existing neurological clinical tests
3. Data analysis

Risk Assessment

1. Computer breaking or not being available
2. Poor or no internet

Research Plan

Plan

Our original research question, “Explore whether developing a hybrid clinical test can improve upon existing neurological clinical tests”, did not fully represent our goal. After careful consideration of the objectives and main task, we developed a new research question which demonstrates the purpose of our research clearly: Can we improve upon multiple aspects of cognitive abilities by combining two clinically approved tests into a single hybrid test?

Due to limited time for this research, the goal of achieving a strong result for whether a hybrid test improves upon the two separate tests is not possible.Therefore we must develop our research and experiments to allow for replication and recreation to truly determine the answer to our research question. For this we need to achieve these key goals:

- Compare our hybrid test to its two counterpart tests (Stroop test and Trail Making Test)
- Design a hybrid test which keeps the fundamentals of both the Stroop test and Trail Making Test

Design

To achieve our previously mentioned goals, we have to understand the fundamentals of the two different tests we will be combining.

Stroop test:

An interactive test, which can be used to assess an individual's cognitive flexibility, processing speed and selective attention by testing the race model theory (the idea that relevant and irrelevant information are processed at the same time but only one piece of information beats the other in a “race” to the central processor during a response selection).

The test displays the name of a colour, such as red, but the text itself is another colour, so the text red can be presented in the colour yellow. The goal is then for the individual to identify what the colour of the text is and select it in a section displaying all possible colours. Effectively feeding the brain two pieces of information, causing the stroop effect (*the delay in reaction time between congruent and incongruent stimuli*)

So for the Stroop test we measure: Reaction time, errors when selecting the the colour of the displayed text, and total test time

Our Stroop test (screenshot of our functional stroop test):

Trail Making Test:

A psychological test which measures visual search speed, scanning, processing speed, and mental flexibility.

It does so by presenting a range of numbers starting from one in a random assortment of circles (numbers 1-5, displayed in five circles, each containing a unique number from the specified range). The aim of the participant is to connect the circles in order starting from one. So in a range of five numbers, the participant must first find one, then connect it to two and so on. Measuring the time it takes for them to complete the test and their accuracy will give us a measurement of the previously mentioned cognitive attributes (visual search speed, scanning, processing speed, mental flexibility)

For the Trail Making Test we measure: Time taken for completion and Accuracy when selecting the next circle in the sequence, we'll also be measuring the time it takes for the participant to select the next number and see if there is any correlation between this and cognitive function.

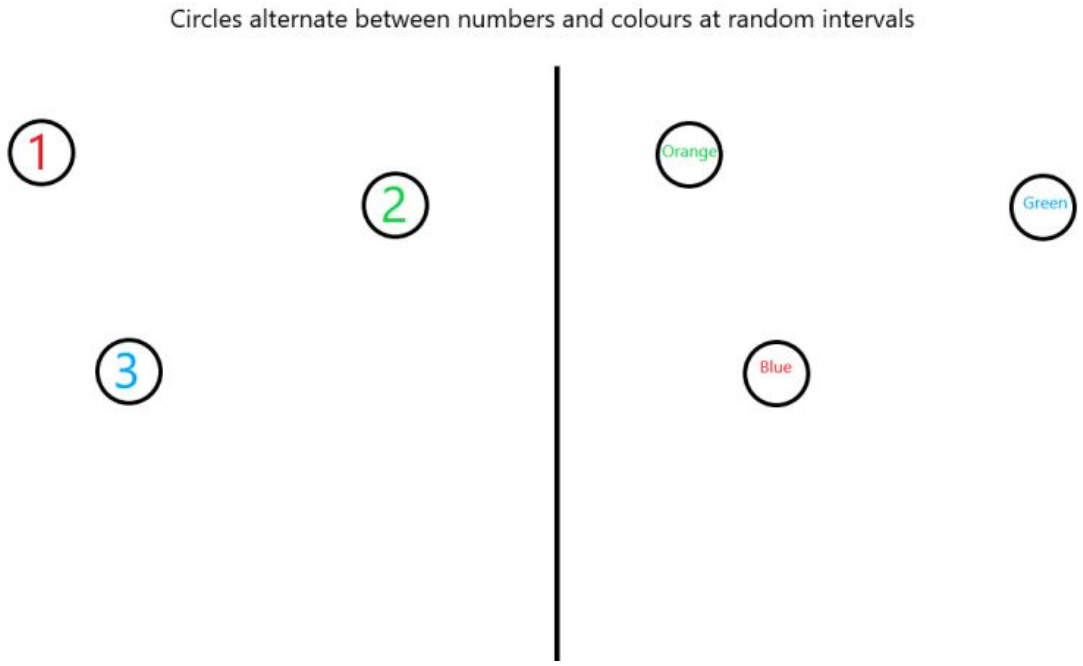
Our trail making test (screenshot of our functional trail making test):

Our hybrid test:

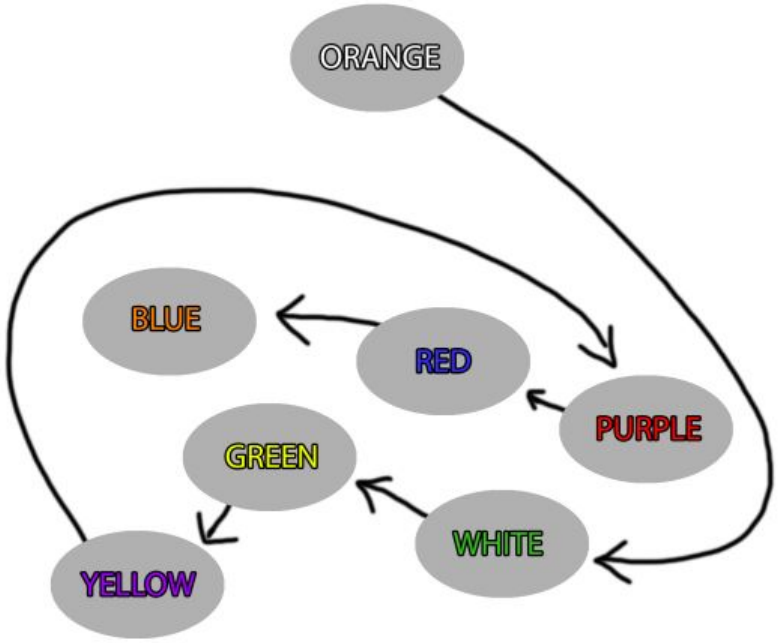
With an understanding of the fundamentals of each separate test, we need a way to combine them into a single test while not only retaining the fundamentals of each game, but by challenging all cognitive traits from the separate tests in our experiment.

Design:
When thinking about the design of our hybrid test we knew that we had to challenge visual search speed/scanning (trail making test) and processing speed (stroop test) to achieve a nicely, well balanced combination of both tests. We came up with a few rough ideas.
Our first concept was to display a normal trail making game, but at random intervals the numbers within the circles would be replaced with text from our stroop test. Although this design did combine both our counterpart tests, we felt it would become too chaotic and would confuse the participant too much, so after revisiting the basic principles of our counterpart tests, we came up with a new design.

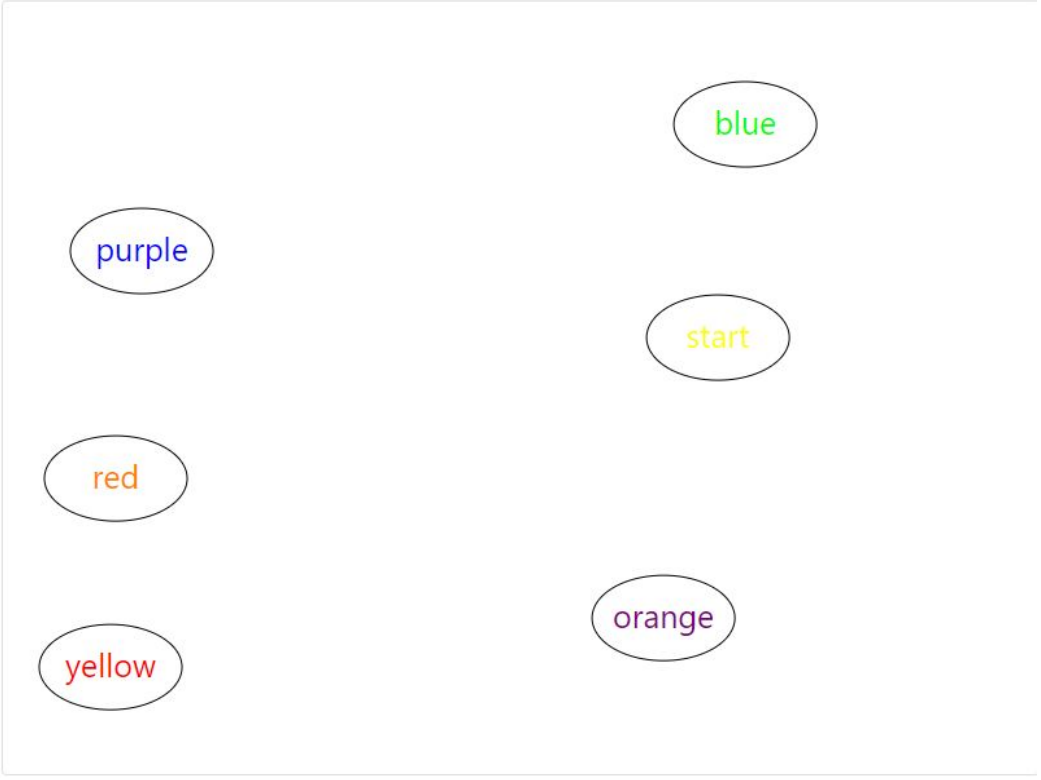
One of the first designs:



The final design:



Our hybrid test (screenshot of our functional hybrid test):



For our new design we eliminated the numbers completely, since processing speed could be measured by measuring how long it took for a participant to process the colour of the text, and seeing how long it took for them to find the colour in our assortment of circles. Therefore we have a more robust and stable design. It tests the stroop effect, by measuring how long it takes the participant to decipher two different pieces of information (the colour of the text, and the text itself), and also tests the participants visual search speed and scanning abilities by having the participant then locate the colour and select it.

Building our experiment:

We will be sticking with our plan to use "React", which was mentioned in our original project proposal to build our hybrid game in. To ensure that our hybrid game produces valid results, we need to compare our results to a control. We opted to not only create our hybrid game in react, but also its counterparts (Stroop test and Trail making test), meaning that we could use them both as a control for our experiment.

The experiment

Since we do not have the time to conclude our research question, we will design an experiment to ensure that our hybrid test is at least valid, and can be picked up and used to answer our research question in the future.

Brief Description:

Our aim now is to ensure that our hybrid test is at least valid, by seeing if it produces somewhat consistent results which have a correlation with our counterpart tests. To do this, each group member will run through our Stroop, Trail Making and Hybrid tests 7 times, with the first attempt being a test run. We will then take the average reaction time of each test (not including the first run), and see if a correlation between our hybrid tests and its counterparts can be made (by calculating the Pearson correlation coefficient for each participants separate tests to see if we can identify a correlation between the counterpart tests and the hybrid test). Finding a correlation between our hybrid tests and its counterparts will suggest that our hybrid test produces results that can be roughly predicted from results gathered by running its counterpart tests, meaning our hybrid test targets the same cognitive areas as the Stroop and Trail making test, making it at the very least a valid test, and an improvement in hybrid test results could suggest an improvement in these cognitive areas.

Participants:

Due to the circumstances we are currently facing with COVID-19, we cannot measure the effects of clinical tests on the elderly individuals we initially wanted to test, therefore the subjects/participants of the project will consist of all members of our group:

1. Bishar Ibrahim
2. Shaun Pruger
3. Darren Tjokro
4. Kaushik Deshpande

5. Lucas Hahn

Equipment:

Computer/laptop
The equipment being used for this research includes a functional computer with access to the following:

1. An internet Connection
   In order to connect to the online servers of the game
2. The clinical tests
- Access to the Stroop Task in order for the subject to be tested for cognitive abilities.
- Access to the Trail Making Test in order to test visual attention and task switching.
- Access to the Hybrid test in order to measure a combination of the two counterpart tests

Our method:
**ensure the tests are run in this specified order*

1. Run through each test as a warmup, do not record results
2. Run through the Stroop test
3. Record results
4. Run through the Trail making test
5. Record results
6. Run through the hybrid test
7. Record results
8. Repeat steps 2-7 a further 5 times
9. Use gathered results to calculate average reaction time
10. Use gathered results to calculate Pearson correlation coefficients and see whether a correlation can be found

Time and task management

The nature of our project involves many moving parts and as such, it is important to be able to delegate tasks in manageable chunks to individuals within our group as well as keep track of the progress to ensure deadlines are met. In order to achieve this, we will be using a combination of a Gantt Chart and a Responsibility Matrix.

A Gantt Chart ensures all tasks within our project are planned and completed at a reasonable time. It also shows the progress of each task in the project. This will give us a clear idea which tasks are running late in the schedule and thus require attention. Each task is assigned to a person to be responsible for the recording, completion and documentation of each task in the Gantt chart.

A responsibility matrix assigns different roles to individuals for each task in the project. These roles include:

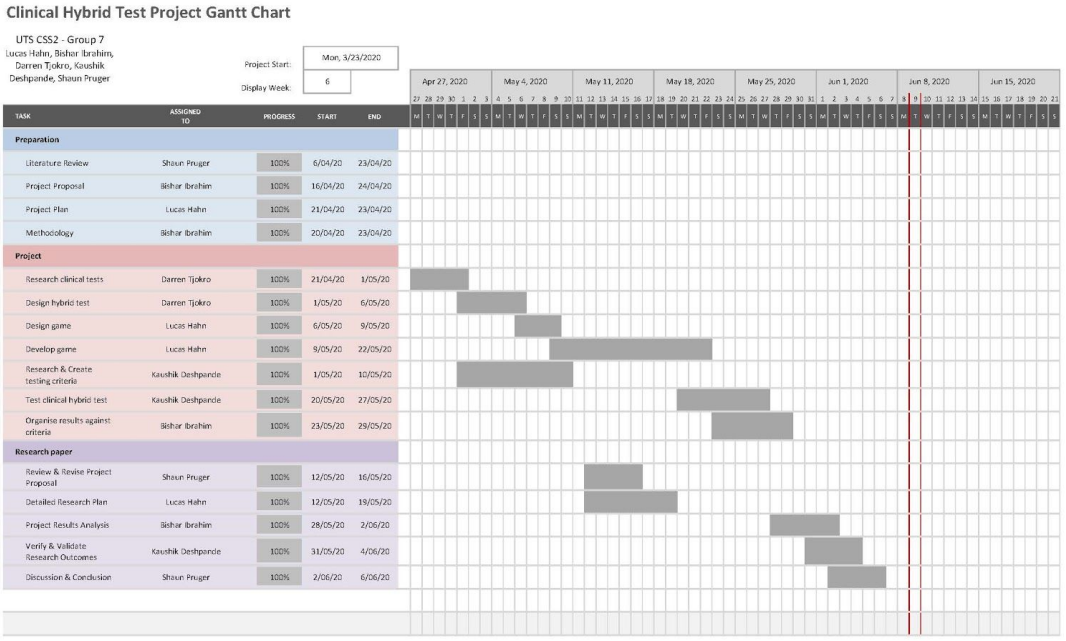
- Primary Responsibility (P)

- Secondary Responsibility (S)
- Must be notified (N)
- Must give approval (A)

This allows us to delegate tasks to people within the project as well as give them accountability to ensure tasks are completed on time.

Lastly, within our group, we each have our own ways of keeping ourselves organised with tasks in our day to day lives. We have decided to let ourselves track deadlines and tasks individually using our personally preferred tools i.e. Google Calendar.

Gantt Chart & Responsibility



Responsibility matrix

Responsibility Matrix

Project task or deliverable	Lucas Hahn	Bishar Ibrahim	Darren Tjokro	Kaushik Deshpande	Shaun Pruger
Literature Review	A	A	A	A	P
Project Proposal	S	P	A	A	A
Project Plan	P	A			
Methodology	A	P			
Research clinical tests	S		P		A
Design hybrid test	S		P	A	S
Design game	P	A			A
Develop game	P	A			A
Research & Create testing criteria			A	P	
Test clinical hybrid test	N	S	S	P	S
Organise results against criteria		P	A	S	
Review & Revise Project Proposal	A	A			P
Detailed Research Plan	P	A			
Project Results Analysis		P	A	S	
Verify & Validate Research Outcomes		S	S	P	A
Discussion & Conclusion	S		S	A	P

Code:

- P = Primary responsibility
- S = Secondary responsibility
- N = Must be notified
- A = Must approve

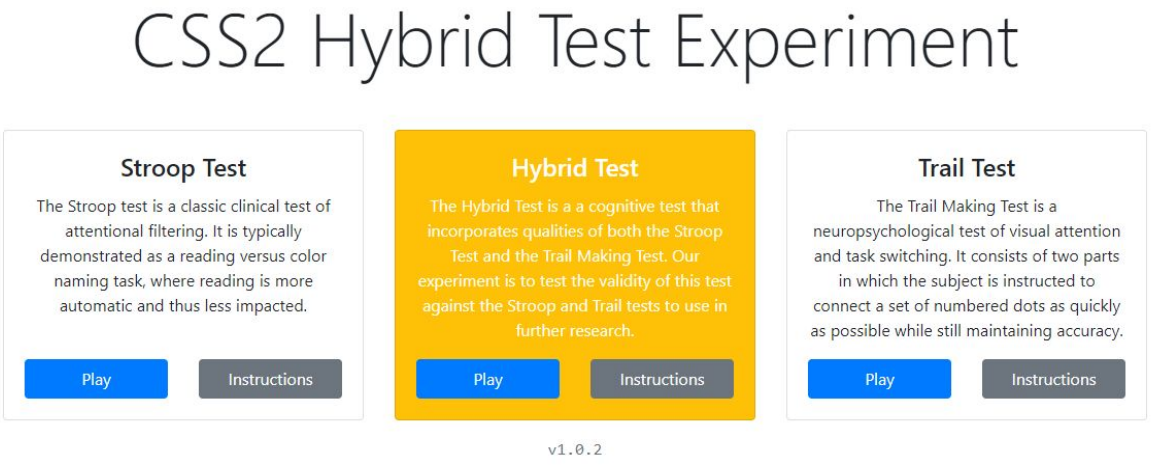
Results Section:

Participants and Bias Minimization

A convenient sample of 5 individuals were recruited in order to attempt these tests. Participants consisted of research students from the University of Technology, Sydney. The eligibility criteria is described as: (1) Has access to a usable computer, which has access to the internet, as well as the provided testing link. (2) Is able to sit for 7 attempts at each provided test (with the first test being a practice attempt), and (3) Allows the use of the achieved results for research purposes.

How we got the results

The experiment conducted in this report can be found at the following link:
http://13.236.137.179:5000/



When accessing the provided link, you will see a screen identical to the display above, which contains 3 different types of tests.

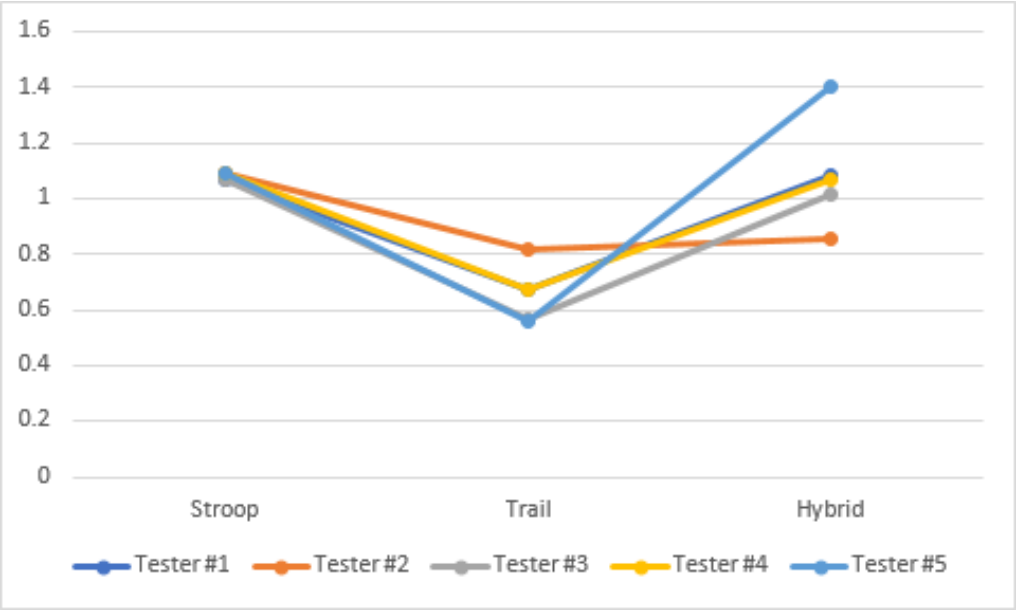
1. Stroop Test
2. Trail Test
3. Hybrid Test (A hybrid of both #1 as well as #2)

Each participant has attempted all three tests 7 times, in the order of Stroop, Trail, then hybrid. The participants were allowed a rest period between each test, in order to eliminate fatigue, recency bias, and keep the testing consistent between all participants. The first attempt was a practice attempt, and will not be used in the results.

After the collection of each individual's raw data, the average reaction time of each test has been calculated in order to create a line graph that can represent this data efficiently.

Overall Statistics

The average reaction time per tester is shown in the following graph:



(Figure 1)

In the line graph above (shown in Figure 1), we can see the results of the 5 testers.

As shown, the five testers were listed at the bottom, each representing a differently coloured line in the graph. The plotted points were split into 3 sections (labeled Stroop, Trail, and Hybrid). What the graph represents is each individual tester's average reaction time, compared to each other. For instance:

The first set of plotted points, shown above the “Stroop” section, show’s each tester's average reaction time for that specific test; you can see that each of the 5 testers have averaged about the same reaction time. For the second set of plotted points, shown above the “Trail” section, you can see that the reaction times vary quite greater than that of the “Stroop” test. In the third section, plotted above the “Hybrid” Section, the reaction times seem to have the widest spread of results, and may contain an outlier.

Do These Results Satisfy The Research Question?

The research question used in the experiment is the following:

Can we improve upon multiple aspects of cognitive abilities by combining two clinically approved tests into a single hybrid test?

According to the results achieved from this research and testing, we can present that the hybrid test functioned efficiently, and was a successful test that provided accurate data, but we were unable to draw enough data to conclude if this test was entirely valid, therefore we will conclude that the research is in fact: inconclusive. The lack of data will not satisfy whether or not improvement can be made through combining two different clinically approved tests into a single hybrid test.

Validating our results

Our hybrid development system is based on both Stroop tests and Trail Making tests. The experiment itself is a program run through the specified website that we made using React framework, our approach is to have each member run the server and document the result produced. It is important to note that the test is randomised, it will produce a different question every time we run the program. From the results gathered in the experiment, we are trying to detect if there is a consistency between the outputs.

As long as there is a consistency in between tests for each member, we can assume that the output of the next try will have/similar outcome as before. Thus, consistency is important in this project as it is based on each individual knowledge and capacity of running through the machine. The consistency can be further calculated using Pearson Correlation Coefficient. We connect the Stroop test with Hybrid test as well as Trail test and Hybrid to explain the correlation between these clinical tests. As there is a time constraint, we made sure that the code for our hybrid machine will be commented thoroughly. This will allow other researches to verify for themselves that each section of the code is performing as intended.

In order to enhance the ability of other experiments, the code for our hybrid test will be commented thoroughly. This will allow other researchers to verify for themselves the benefit of the hybrid system opposed to both Trail making and Stoop test and verify that each section of the code is performing as intended.

There is one significant potential issue with regards to the validity of our experiment. Due to unfortunate circumstances of Covid-19, testing and verification of our system is well beyond the feasible limits of the projects with regards to social distancing, time constraints, resources availability and the small samples as only our team members try the hybrid test.

Because of these issues, we are trusting the outcomes of each test which can be biased as there are many elements that can influence the outcome of each test which make the outcome not accurate. This can be caused if the participants were colour blind which can affect tremendously the Hybrid test as they need to see the colour itself. Finally, we also acknowledge that the system may not be perfect and further research is needed to make this Hybrid test more reliable for the broader participant.

Group Member	Program	Result (averaging 6 tests)<ms>	Pearson R of other program versus Hybrid
Tester 1	Stroop	1.071	-0.055
	Trial	0.673	-0.1555
	Hybrid	1.082	1
Tester 2	Stroop	1.068	0.0376
	Trial	0.57	0.0868
	Hybrid	1.015	1
Tester 3	Stroop	1.113	0.5618
	Trial	0.842	-0.3658
	Hybrid	0.881	1
Tester 4	Stroop	1.091	0.6392
	Trial	0.678	0.3037
	Hybrid	1.073	1
Tester 5	Stroop	1.09	-
	Trial	0.56	-
	Hybrid	1.4	1

Program	Result (averaging 6 tests)<ms>	Pearson R of other program versus Hybrid
Stroop	1.0818	0.2037
Trail	0.6606	-0.7462
Hybrid	1.0852	1

Something we must consider is the accuracy of our dataset. Since the examples are generated by group members with knowledge on how the system works, they are not entirely accurate representations of the behaviour of other partiticant with limited to none knowledge on the

system. We also ran through each test more than once to verify that we obtained similar results. From the result above, we found that the Hybrid test will take more than 1 to 1.5 times needed to finish from the trial test but less time from the Stroop test. The result of the Pearson P variable can be a clear indication of the correlation between one machine learning to another. The result can be both positive and negative. If the Pearson P value equals or trends to 0, it indicates that there is zero correlation between tests. With the verified results, we can begin to conclude whether the Hybrid Clinical test is technically valid in measuring cognitive abilities.

Discussions Section:

Future of the project:

Our results have not had enough data in order to conclude that the hybrid test can be used to improve upon the two clinically approved tests, Stroop, and the Trail Making test. Therefore we hope that our methodology will be re-used in the future in order to recreate the environment needed to collect data. Also, ensuring a greater number of testers in order to generate a larger data set to validate that the hybrid test can in fact be used to improve upon the two other tests.

Using different approved clinical tests like the Stroop, and Trail making test has been fundamental to analysing the reaction times of each individual tester, therefore we believe that with future testing, and more participants, we can conclude better results for our next outcome.

Conclusion Section:

The Hybrid Clinical Test has a lot of promise in being used as a neuropsychological test for cognitive abilities. However, due to the lack of a proper results sample and therefore analysis, we cannot confidently say that the Hybrid Clinical Test is technically valid. Thus our answer to the research question is inconclusive. With further research and experimentation, it is hoped that the Hybrid Clinical Test can be proven as a technically valid test in the future and therefore used as an accurate tool to measure or improve cognitive ability.

Bibliography

Stroop, J., 1935. Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18(6), pp.643-662.

Scarpina, F. and Tagini, S., 2017. The Stroop Color and Word Test. *Frontiers in Psychology*, 8.

Psytoolkit.org. 2020. *Stroop Effect*. [online] Available at: <https://www.psytoolkit.org/lessons/stroop.html> [Accessed 9 June 2020].

Arnett, J. and Labovitz, S., 1995. Effect of physical layout in performance of the Trail Making Test. *Psychological Assessment*, 7(2), pp.220-221.

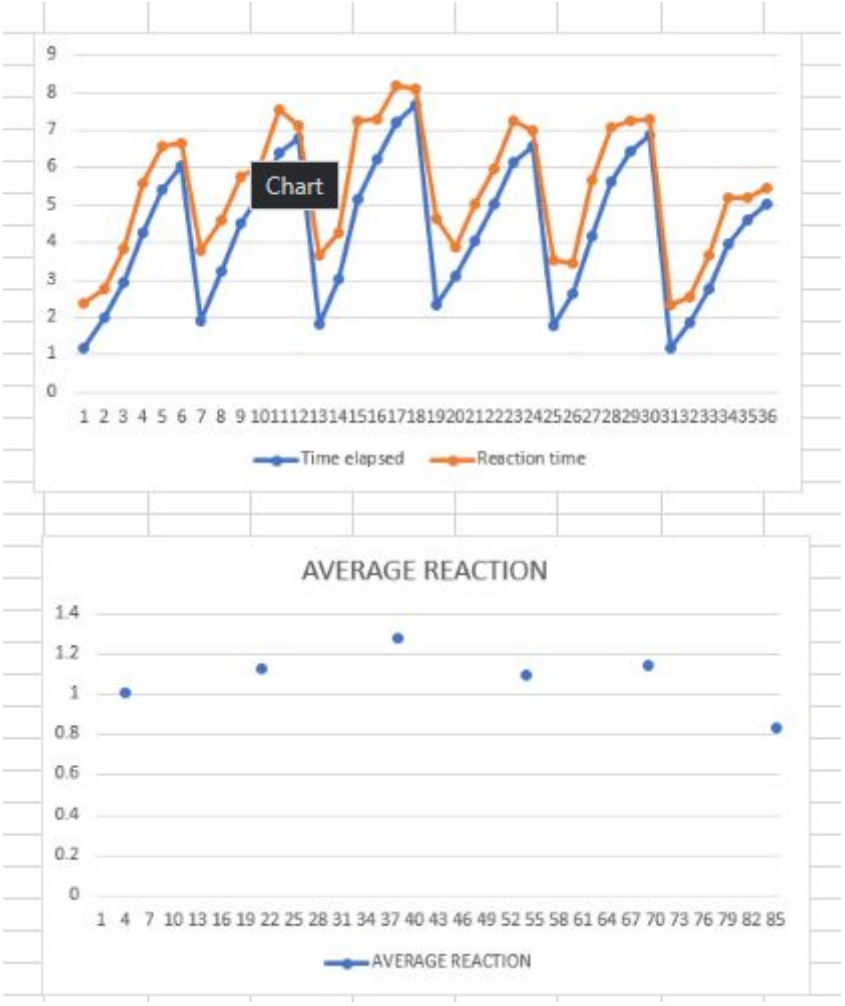
Appendix

Lucas Hahn

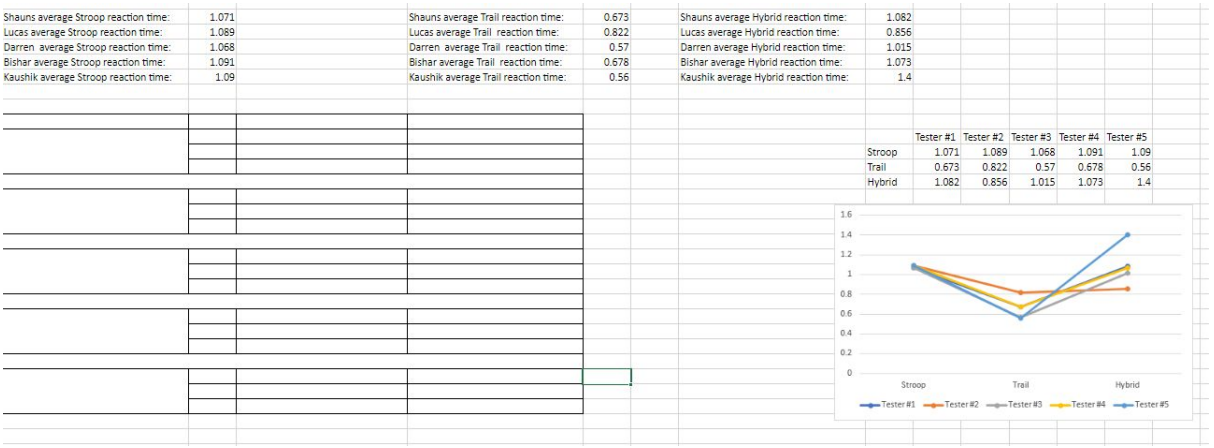
- Created the CSS2 Hybrid Test React App (https://github.com/lucash-0/CSS2-Hybrid-Test)
- Created the Stroop Trails Hybrid React Component (https://github.com/lucash-0/react-stroop-trails-hybrid)
- Forked Trails from ORCATECH for our CSS2 Trails Component (https://github.com/lucash-0/react-neuropsych-trails)
- Used Stroop from ORCATECH for our CSS2 Stroop Component (https://github.com/orcatechteam/react-neuropsych-stroop)

Bishar Ibrahim

- Created Methodology in Assignment 1
- Drew different types of layouts the game could look like.
- Created an Excel tab for every individuals test to pack up the raw data provided by the CSV files through the created game:



- Created an Excel sheet with everyone's overall average results provided by the Game:



Shauns average Stroop reaction time:	1.071
Lucas average Stroop reaction time:	1.089
Darren average Stroop reaction time:	1.068
Bishar average Stroop reaction time:	1.091
Kaushik average Stroop reaction time:	1.09

Shauns average Trail reaction time:	0.673
Lucas average Trail reaction time:	0.822
Darren average Trail reaction time:	0.57
Bishar average Trail reaction time:	0.678
Kaushik average Trail reaction time:	0.56

Shauns average Hybrid reaction time:	1.082
Lucas average Hybrid reaction time:	0.856
Darren average Hybrid reaction time:	1.015
Bishar average Hybrid reaction time:	1.073
Kaushik average Hybrid reaction time:	1.4

	Tester #1	Tester #2	Tester #3	Tester #4	Tester #5
Stroop	1.071	1.089	1.068	1.091	1.09
Trail	0.673	0.822	0.57	0.678	0.56
Hybrid	1.082	0.856	1.015	1.073	1.4

- Written out the results section in Assignment 3
- Explained what the results mean, and written out the conclusion of our experiment
- Wrote the discussion section for Assignment 3, and what the future of our project holds.

Shaun Pruger

- Researched existing clinical tests
- Created Literature Review in Assignment 1
- Created one of the designs for Hybrid test
- Created the Research Plan for Assignment 3
- Created the method for Assignment 3
- Formatted Assignment 3
- Presented work during both presentation tutorials

Darren Tjokro

- Approved literature review
- Formatted final Assignment 1 report
- Validated and Verified results for Assignment 3
- Tested hybrid test

Kaushik Deshpande

- Worked on Research Question
- Formatted final Assignment 1 report
- Helped conclude the results
- Tested hybrid test
- Formatted Assignment 3
- Organized Time Management and Tasks