



The Mind at work;
Reaction speed vs. Visual Stimuli

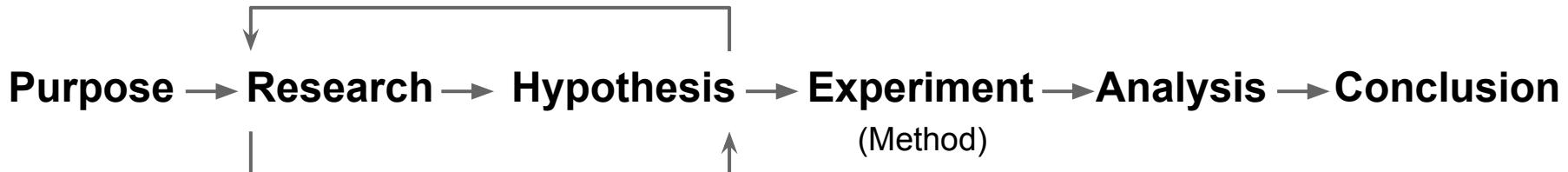
Andrew Reece, Lucy Milson, Felix Rosen,
Matthew Party, Joe Alexander

Introduction

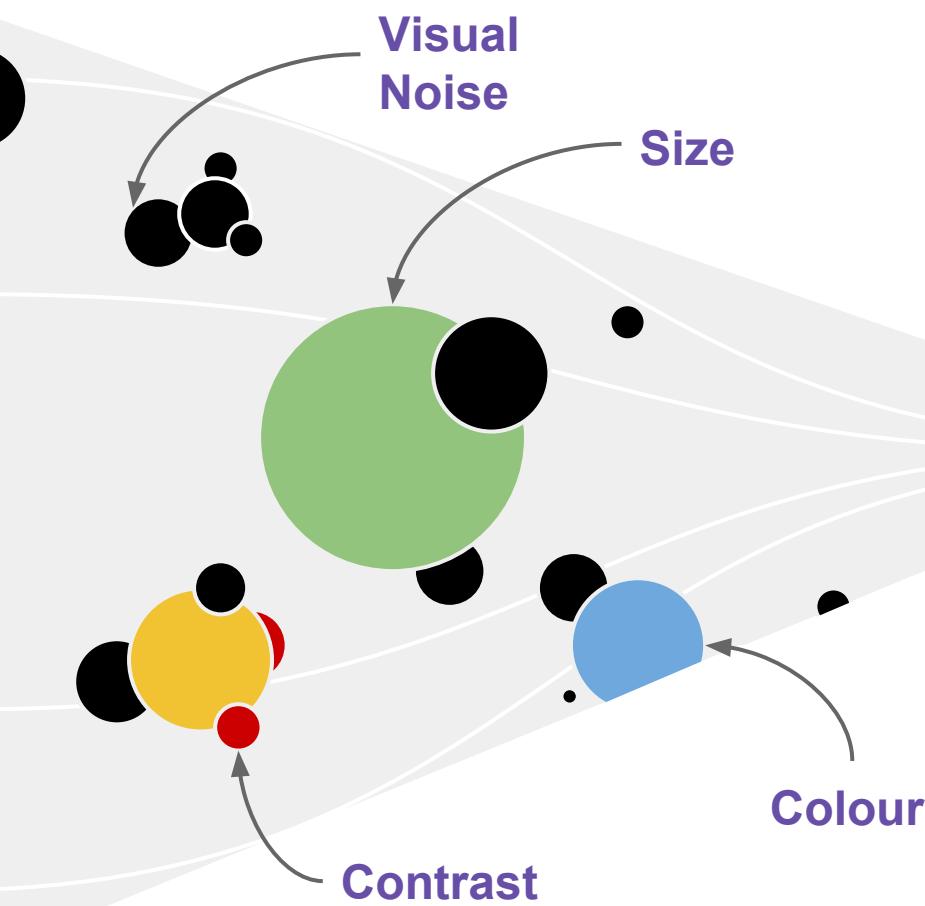
“Measuring Reaction Speed based on a series of varying visual stimuli”

Causal relationships → Experimental method

Scientific Method



Purpose



Stimulus → visual receptor → Cognition → Response

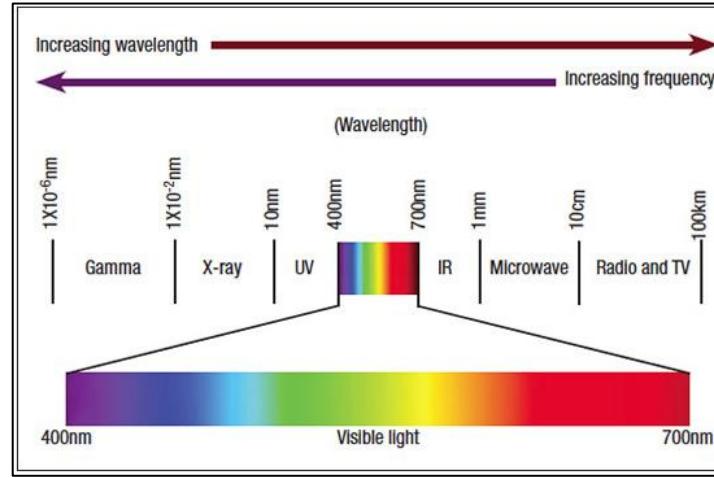
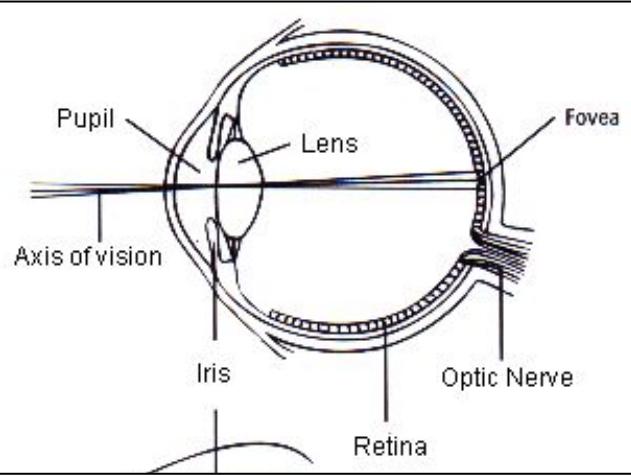
Would a specific **stimulus** affect
reaction time more than the others?

Research

Reaction Speed

Stimulus → Retina → Brain → Nerve response → Motor Response = What we're measuring

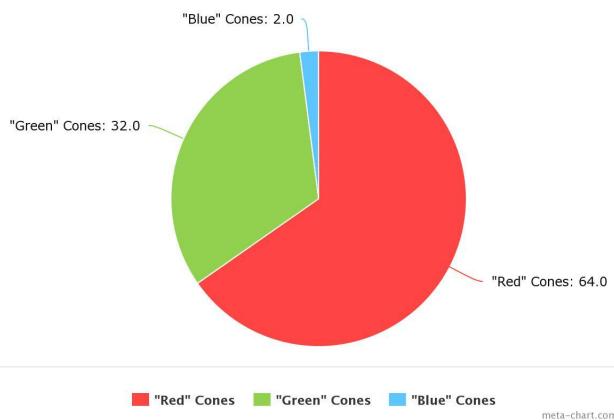
Eye structure



Translate **Visual Light wavelengths** into images, through the interpretation by the **Rods** and **Cones** found in the **Retina**.

Research - *Photopic* vs *Scotopic*

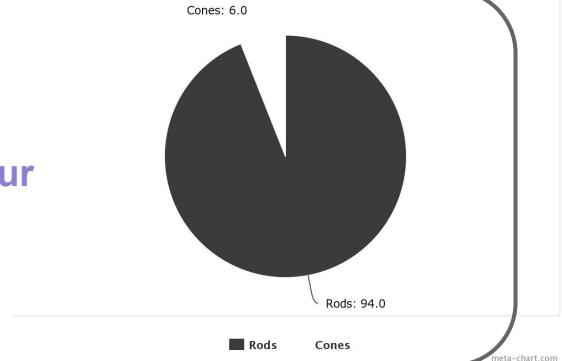
Photopic Vision



- “**Presence** of Colour” (**Red**, **Green**, **Blue**)
- Controlled by **Cones**, located in the **Fovea** and can **perceive colour**
- Cones are sensitive to **Higher wavelengths** (>550) and can **differentiate between colours**.
- 7 Million
- **Blue Cones are Unique** { Located **outside the Fovea**
Detect 445nm light waves }

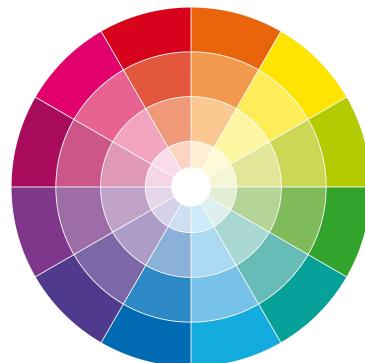
Scotopic Vision

- “**Absence** of colour”
- Controlled by **Rods**, located in the **peripherals** and **cannot perceive colour**
- Rods are sensitive to lower wavelengths (<445)
- There are **120 million Rods** across your retina



COLOUR

Colour is the property, possessed by an object, of producing different sensations on the eye as a result of the way it reflects or emits light.





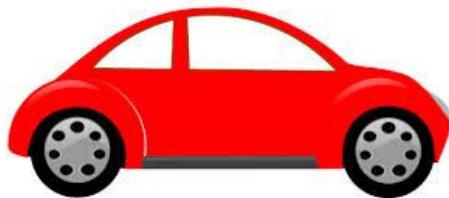
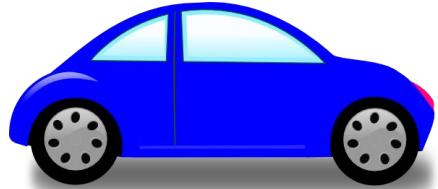
UNIVERSITY of
ROCHESTER

Rochester University - Colour controlled more by brain than eye

Corpuscular theory - green light carries greater energy than red

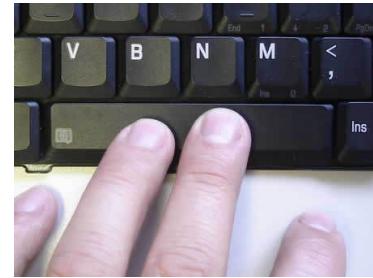


RESEARCH

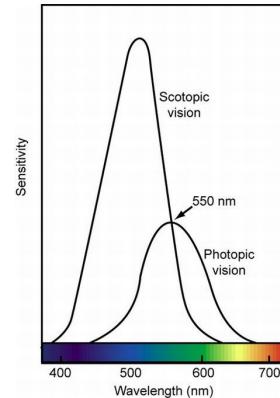


Visual reaction time = faster for red than green

This research suggests that the colour of the stimuli does have an influence on the speed of the reaction.



Study - effect of colour of object on simple visual reaction time in normal subjects

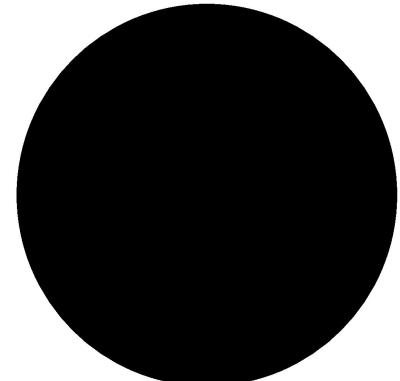
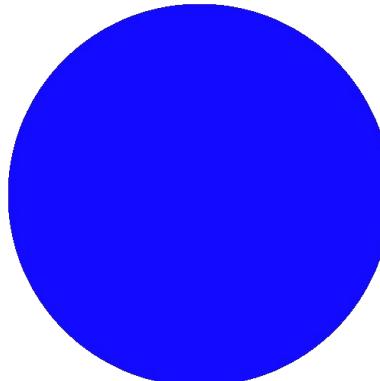
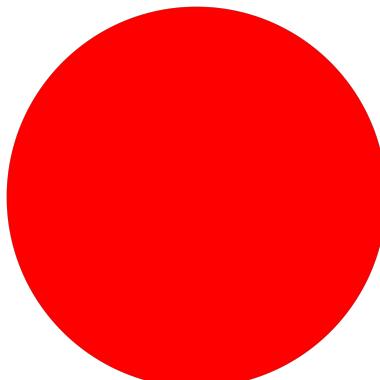
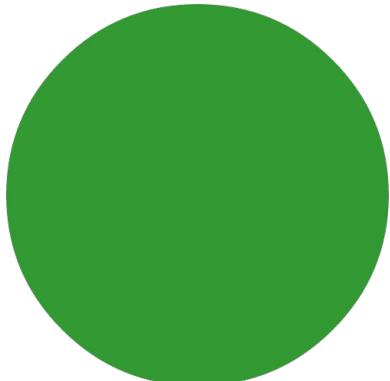


HYPOTHESIS

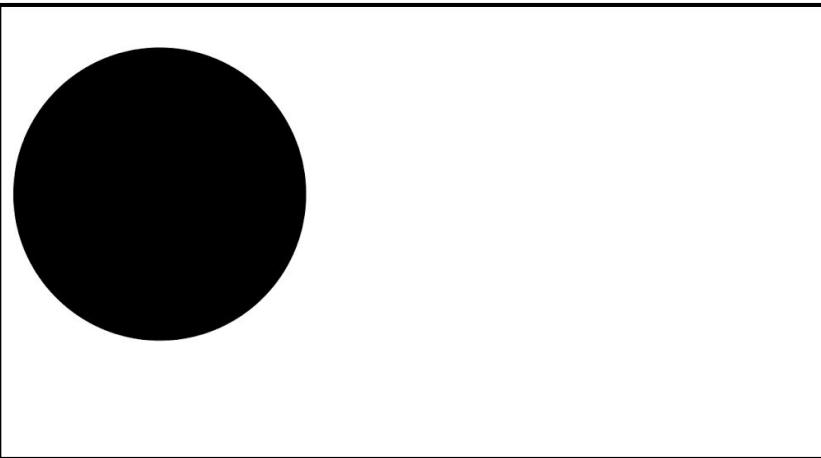
A stimulus of the colour Blue
will have the highest
Reaction Speed

Representation

- random amount of time on white background
- circle appears in random place on screen
- coloured either - green, red, blue or black



Size



“The relative extent of something; a thing’s overall dimensions or magnitude; how big something is”

(oxforddictionaries.com, 2015)

Size-Research

“Study examines the viewer's cognitive **response as a function of banner ad size** and type in a lab experiment...”

“...large banner ads lead to better comprehension and more clicks than small banner ads.”

- The larger and more animated the advert, the more clicks it received

In relation to our experiment...

- The larger the stimuli, the faster the reaction time from the participant due to the size being more noticeable.



Size-Research

Experiment involving speed, direction and object size, and the influence these stimuli had on prediction:

“Twenty boys and 20 girls, 7 yr old, participated in a study assessing the influence of a moving object's speed, size, and direction and the subject's sex on the prediction of object directionality.

... It was concluded that object speed and direction had a greater influence than object size on the prediction of direction.”



Driver	92.6%
improper lookout	23.1
excessive speed	16.9
inattention	15.0
improper evasive action	13.3
internal distraction	9.0
improper driving technique	9.0
inadequate defensive driving	8.8
false assumption	8.3
improper maneuver	6.2
overcompensation	6.0
other (blackout, dozing, etc.)	5.8

Ridenour, M. (1974). Influence of object size, speed, and direction on the perception of a moving object. Research Quarterly. American Alliance for Health, Physical Education and Recreation

Size - Hypothesis

With the Increase in Size of stimulus
there is a Increase in reaction speed

Size- Representation concept

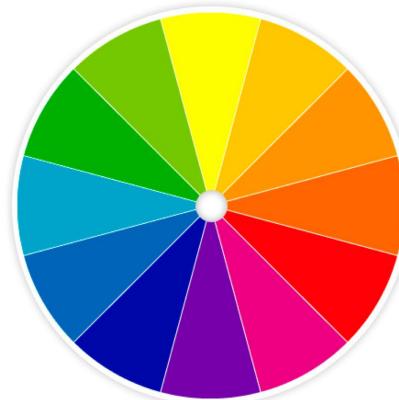
How the programme worked?

- For 'size', the programme worked by initially presenting a plain white background
- After 1 to 10 seconds a circle will appear on the screen
- The circle will be a range of sizes
- The participant will have to press the spacebar on the keyboard as quickly as possible once the circle is presented
- The more pixels that made up the circle, the larger the size of stimulus
- Therefore we expect that the larger sized circle, the faster the reaction time of the participant

Contrast - Introduction

What is it?

- In this context contrast refers to the ‘differences in colour, tone, or shape that contribute to the visual effect of a design or image’ ([Oxforddictionaries.com, 2015](https://www.oxforddictionaries.com)).
- In simple terms, the highest contrast of two colours or shapes would be direct opposites. For example, purple would be a contrast to yellow or green contrasts red.



Contrast Research

- Majority of research studies into contrast concluded higher contrast will decrease reaction time to the stimuli, for example:

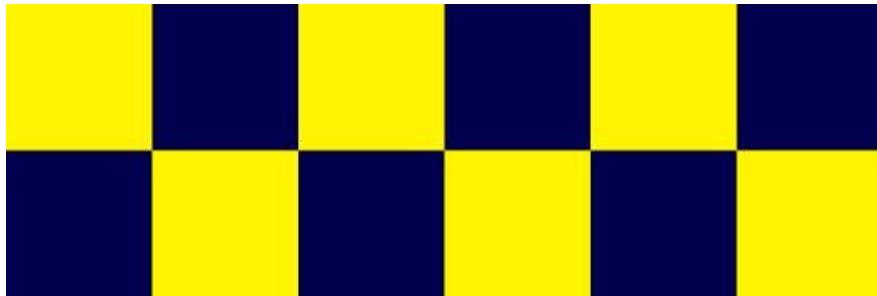
Luminance Contrast Influences Reaction Time in Young and Older Adults- Patrick J. Grabowski and Andrea H. Mason

- This study, investigates the effect of luminance contrast level on reaction time to a visual stimulus in both young and senior adults.
- Results indicate that young adults have faster reaction times than seniors
- But both groups improved reaction times with increasing luminance contrast of the target.
- Young adults improved at lower levels of contrast than seniors.

Contrast - Where is it used?

Vehicle safety

- Contrast plays role in the safety of road users.
- Applied to the colours and luminosity of road signs and significant there importance
- One of the biggest applications of research into contrast has been applied to police and other emergency vehicles to make other roads users visually aware of their presence.



- The Battenberg design applied to emergency vehicles after various laboratory trials over a six month period to create the National Guidance document of 2004.

Contrast- Hypothesis

With the Increase in Contrast between stimulus and background there is an Increase in reaction speed

Contrast-Representation Concept

How does the programme work?

- White background presented
- After 1 to 10 seconds a circle will appear on the screen
- The circle will be a range of greys, from 0 being white and 255 being black
- Participant presses space bar when see the stimuli
- The higher the shade number of the circle the higher the contrast
- Expect that the higher the shade number the shorter the reaction time of the participant

Why we chose this method?

- The contrast can be varied greatly so any trends in the reaction time can be analysed in greater detail after to provide more conclusive results.
- Also the programme randomly generates the strength of contrast making the test both fairer and quicker so more participants can be tested.

Visual Noise - Introduction

Real Life Visual Noise



“Visual noise is anything that may **distort, transform, block** or **add** to what we see”



Increasing the time taken during the cognitive process



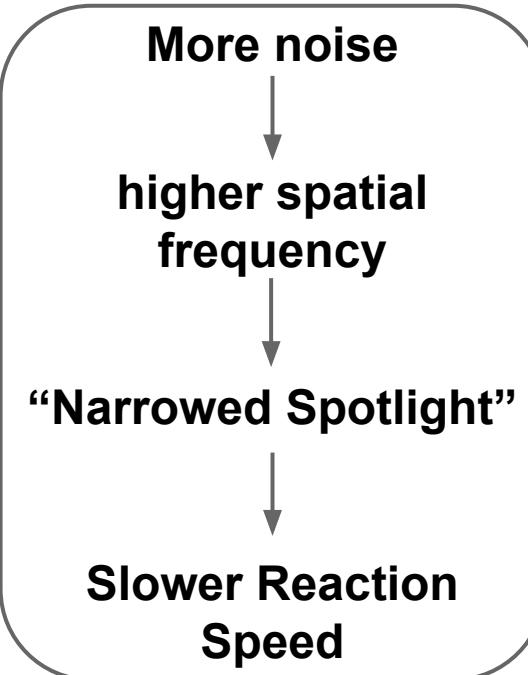
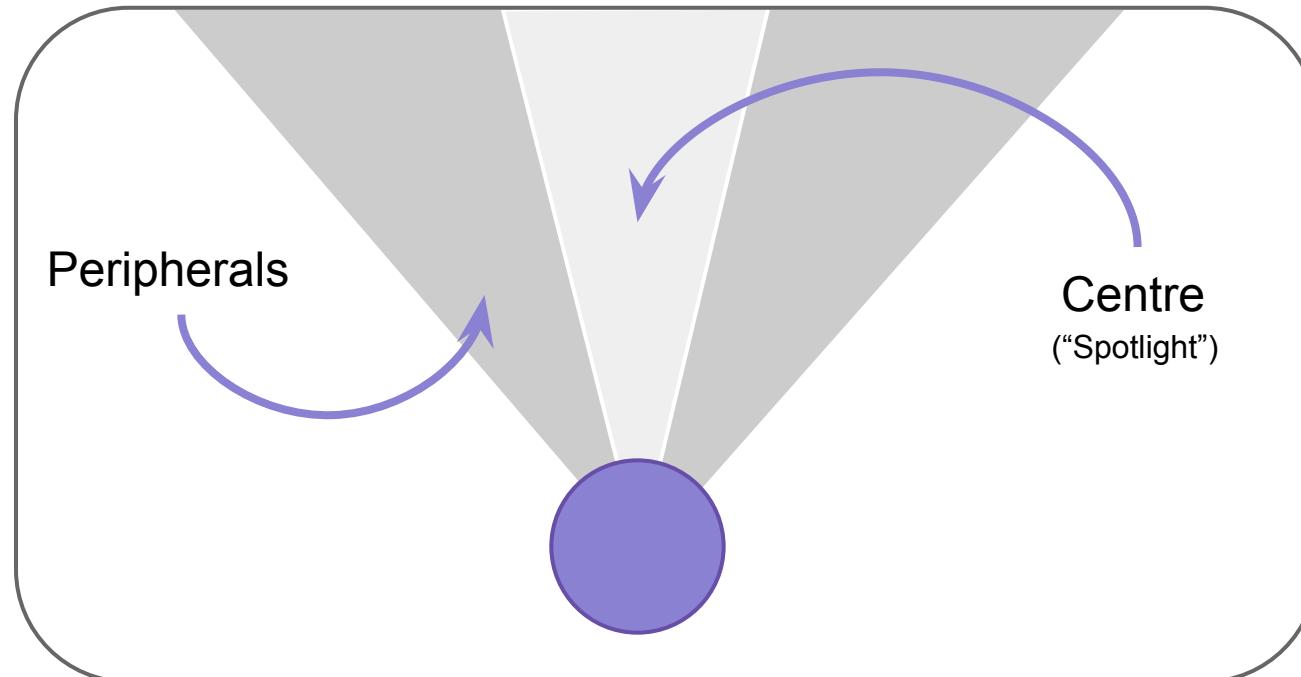
Each element requires **focused attention** and **analysis**



Visual Noise - Research

Leonard J. Williams, Psychology Department, University of South Dakota

“Visual Noise causes Tunnel Vision”



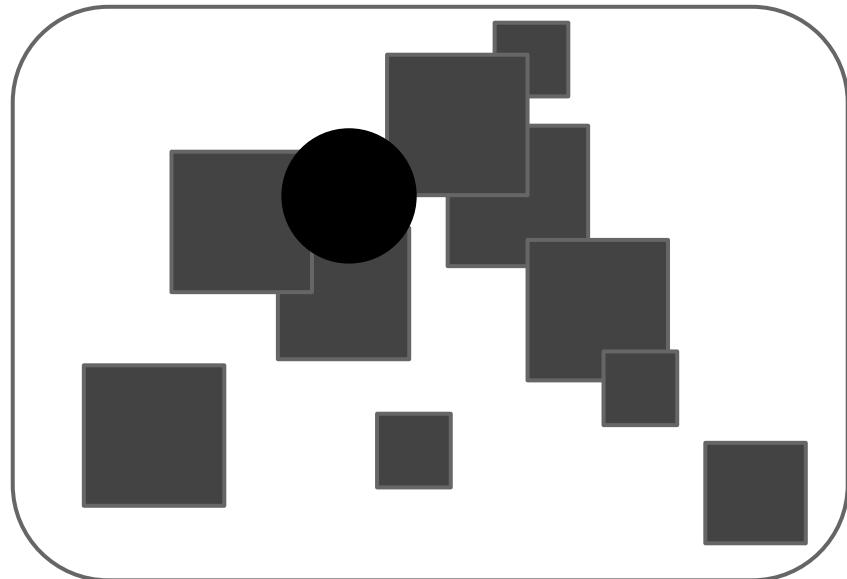
“the main sources of degradation are the stochastic noise in the image and the suboptimal visual processing”

Visual Noise - Hypothesis

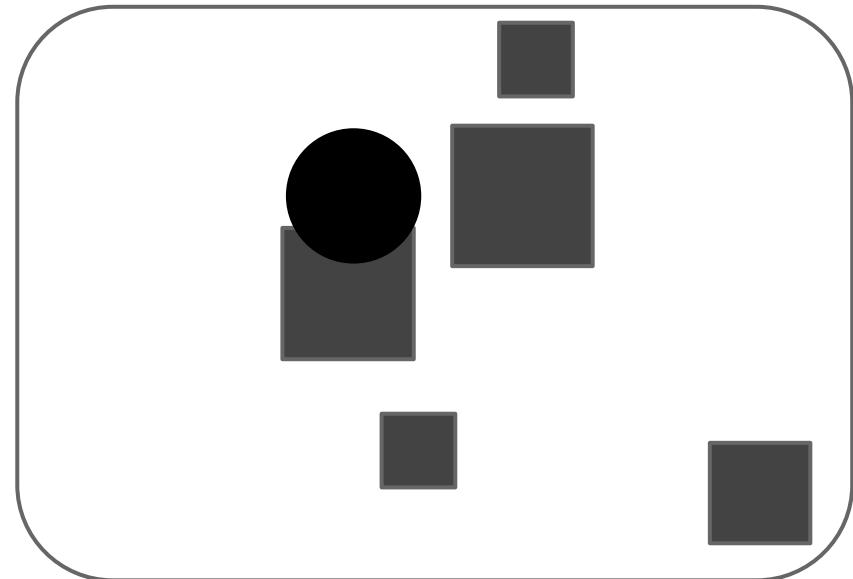
With the Increase in visual noise,
there is an Increase in reaction speed

Visual Noise - Concept

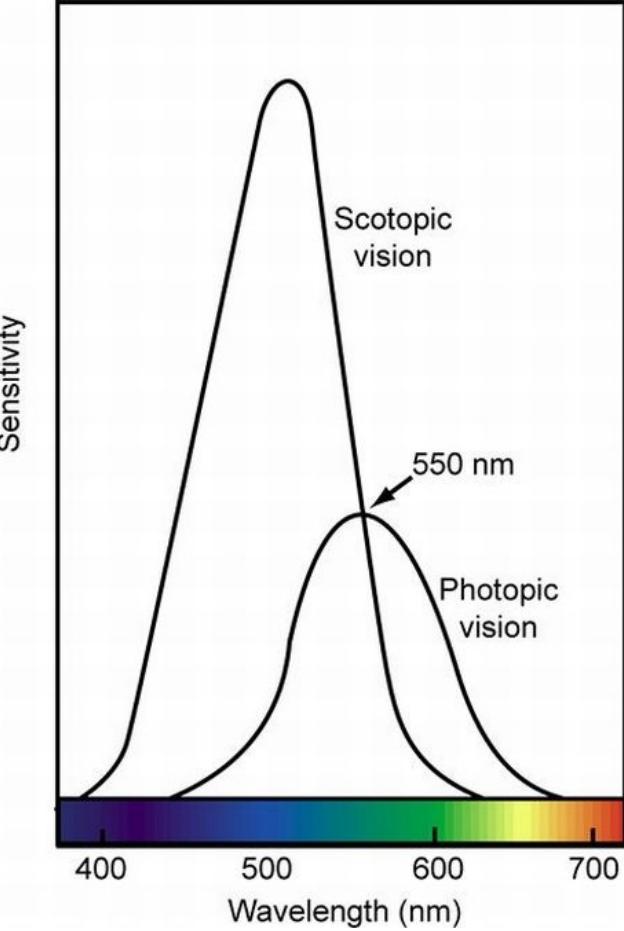
High spatial frequency



Low spatial frequency



Hypothesis



“Reaction Time will decrease with Increased Contrast, Decreased noise, Greater size and use of the colour Blue”



Experiment - Variables

Independent Variables

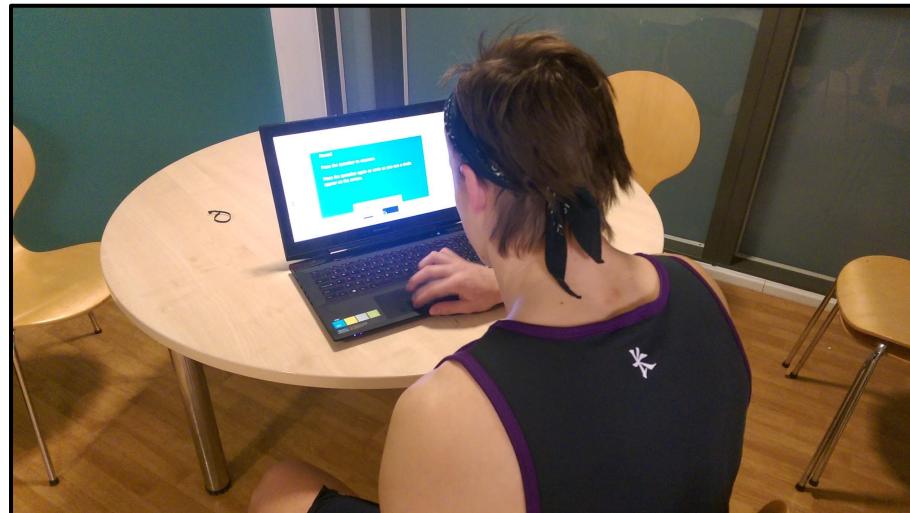
- Size → White background // Black circle // Different sizes
- Colour → White background // Altered circle colour // Same size
- Contrast → White background // Altered circle tone // Same size
- Noise → Different background // Black circle // Same size

Dependant Variables

- Reaction time

Confounding Variables

- Lighting
- Room temperature
- Familiarity with keyboard
- Sight impairment
- fatigue



Method - Application

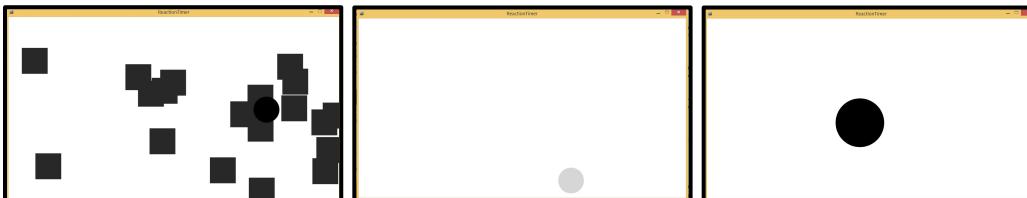
```
ReactionTimer | Processing 2.2.1
File Edit Sketch Tools Help
Java
ReactionTimer Square colourTest contrastTest displayCircle displaySquare pause sizeTest visNoiseTest
boolean buttonPressed = false; //to prevent repeat button presses in single test
boolean variationChosen = false; //do one variation at a time
boolean[] variationsDone = {
    false, false, false, false, false
};
String[] variations = {
    "Size", "Colour", "Contrast", "Visual Noise"
}; //for printing
int maxPause = 1000; //start each test with a pause
for (int i = 0; i < variations.length; i++) {
    variationsDone[i] = false;
}
int margin = 1; //min number of blank pixels from edge of screen

int unpauseHilit;
int conditionSize;
int startTime;
int endTime;
int timeTaken;
PVector pos; //randomize position
boolean posChosen = false;

static final int SIZE = 0;
static final int COLOUR = 1;
static final int CONTRAST = 2;
static final int VIS_NOISE = 3;
int testVariation;
float waitTime;

int defaultSize = 100;
int minSize = 1;
<

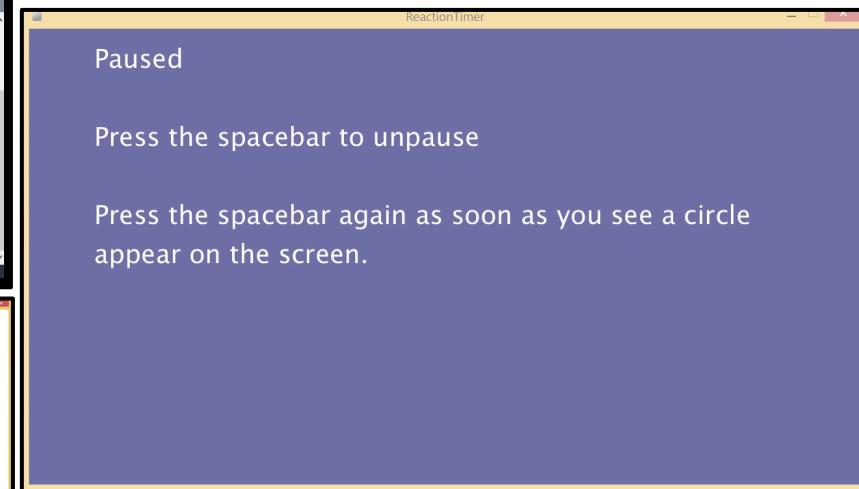
-----
chosenVariation: Visual Noise
wait time: 9694.292
visNoise: 33
endTime: 466
-----
chosenVariation: Contrast
wait time: 2691.924
contrast: 57.514786
endTime: 784
-----
chosenVariation: Colour
wait time: 7846.799
colour: Black
endTime: 384
-----
chosenVariation: Size
wait time: 4252.1646
size: 73.00064
endTime: 34
-----
```



Process

- The program will progress through the various tests randomly as to eliminate order effects
- The program has been scripted to measure the participants reaction time from the moment the shape appears, to the moment the participant "reacts" by pressing the space key on the keyboard.

(this will be recorded in milliseconds).



Paused

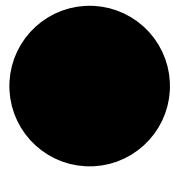
Press the spacebar to unpause

Press the spacebar again as soon as you see a circle appear on the screen.

ReactionTimer



ReactionTimer

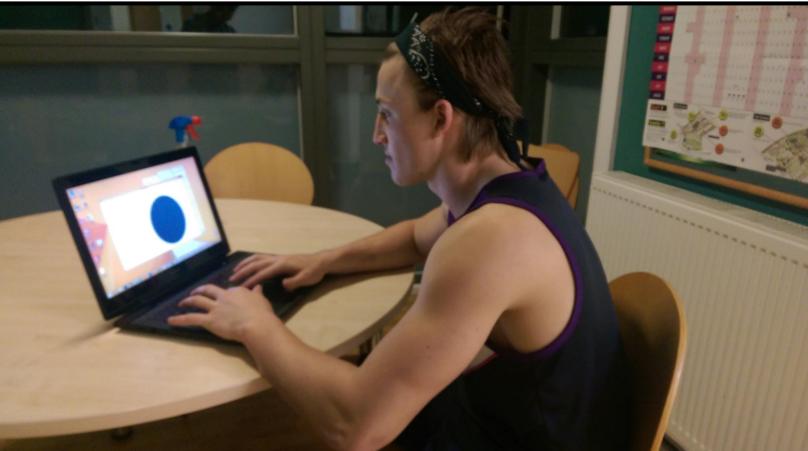


Paused

Press the spacebar to unpause

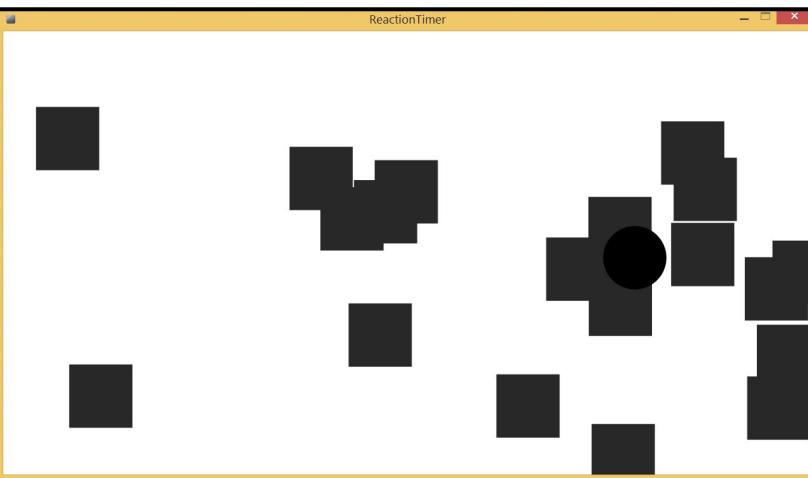
Press the spacebar again as soon as you see a circle appear on the screen.

Method - Benefits



- Incredibly Accurate (MS)
- Mobile
- Clear Representation

- Consistent
- Speed (small time commitment)
- Potential online usage



```
chosenVariation: Visual Noise
wait time: 9694.292
visNoise: 33
endTime: 466

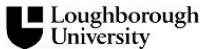
chosenVariation: Contrast
wait time: 2691.9224
contrast: 57.514786
endTime: 784

chosenVariation: Colour
wait time: 7840.799
colour: Black
endTime: 384

chosenVariation: Size
wait time: 4252.1646
size: 73.800064
endTime: 34
```

The code block shows four variations of visual noise with their respective parameters. The last variation, "chosenVariation: Size", is highlighted with a red rectangle around the "endTime: 34" line.

Experiment - Ethics



DSA114 Mind at Work

INFORMED CONSENT FORM

The purpose and details of this study have been explained to me. I understand that this study is designed to further scientific knowledge and that all procedures have been approved by the Loughborough University Ethical Approvals (Human Participants) Sub-Committee.

I have read and understood the participant information sheet and this consent form.

I have had an opportunity to ask questions about my participation.

I understand that I am under no obligation to take part in the study.

I understand that I have the right to withdraw from this study at any stage for any reason, and that I will not be required to explain my reasons for withdrawing.

I understand that all the information I provide will be treated in strict confidence and will be kept anonymous and confidential to the researchers unless (under the statutory obligations of the agencies which the researchers are working with), it is judged that confidentiality will have to be breached for the safety of the participant or others.

I agree to participate in this study.

Your name _____

Your signature _____

Signature of investigator _____

Date _____

DSA114 – Mind at Work

Measuring reaction time based on a series of varying visual stimuli

This work is being conducted as part of the coursework requirements for DSA114 Mind at Work module at Loughborough Design School, Loughborough University. The work is being conducted by first year BSc Ergonomics students, under the supervision of the module leader, Dr Ruth Sims.

Aims

The aim of the study is to investigate whether reaction time increases with certain applications of varying independent variable conditions the stimuli we will be testing will be:

- Size
- Colour
- Contrast
- Noise

What is involved?

You will be presented with a computer program that will alternate through various tests that will undertake by pressing a space key on the keyboard. The tests will take no more than five minutes

What happens next?

If you are happy to take part, you will be asked to read and sign a consent form. Any data collected from you will only be used in this piece of project work and will be stored anonymously. You are free to stop taking part at any time, and do not need to give a reason for doing so. If you do wish to stop participating, please just tell the students and all data collected from you up to that point will be destroyed.

You have the opportunity to receive confectionary in exchange for your services to us

All projects have completed Ethical Advisory Checklists and are being conducted under appropriate Ethical Committee guidelines.

If you have any questions or concerns about this project or your part in it please contact Dr. Ruth Sims r.e.sims@lboro.ac.uk

Additional Information?

- Gender _____

May yield more potential results..?

- Age _____

Method - Data Collection



```
chosenVariation: Visual Noise
wait time: 9694.292
visNoise: 33
endTime: 466

-----
chosenVariation: Contrast
wait time: 2691.9224
contrast: 57.514786
endTime: 784

-----
chosenVariation: Colour
wait time: 7840.799
colour: Black
endTime: 384

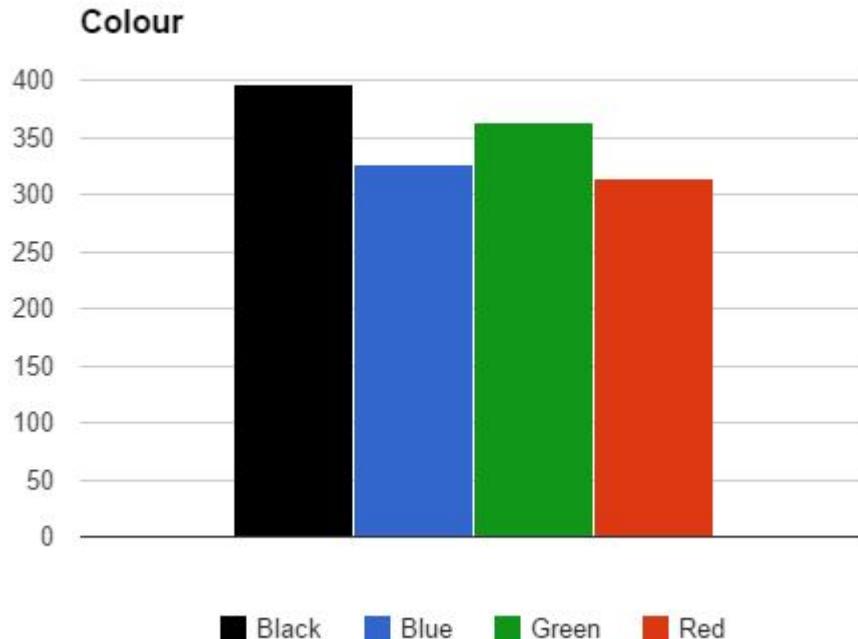
-----
chosenVariation: Size
wait time: 4252.1646
size: 73.800664
endTime: 34

-----
22
```



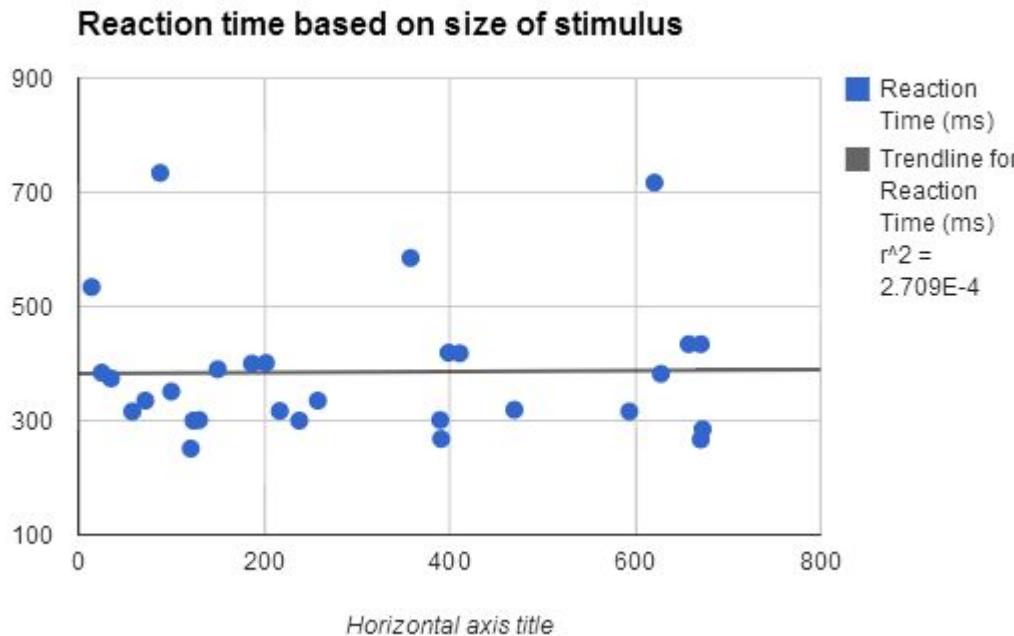
1. The experiment had been conducted in **Pilkington library**, at a time that was suitable and convenient for all group members.
2. We had set up a "**booth**" and asked students as they entered or exited through the door to participate.
3. We then sat the participant down and **presented them with Andrew Reece's program**
 - The program had progressed through the tests **randomly** as to eliminate order effects
4. Collected data had been processed into graphs and conclusions were drawn.

Colour results



- red has the fastest average reaction time in milliseconds compared to green, blue and black with an average of just over 300 milliseconds
- black had the slowest average reaction time with almost 400 milliseconds
- big difference to other colours
- suggests that the colour of the stimuli does have an affect on the speed of the reaction

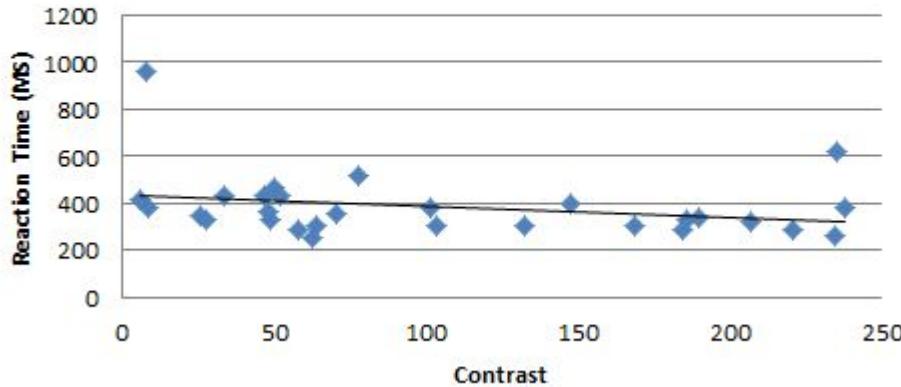
Size Results



- The results were generally random, showing no real correlation.
- This proved that the size of the stimulus didn't have an affect on the participant's reaction time
- Increasing the sample size could potentially improve these results, as a pattern may start to form

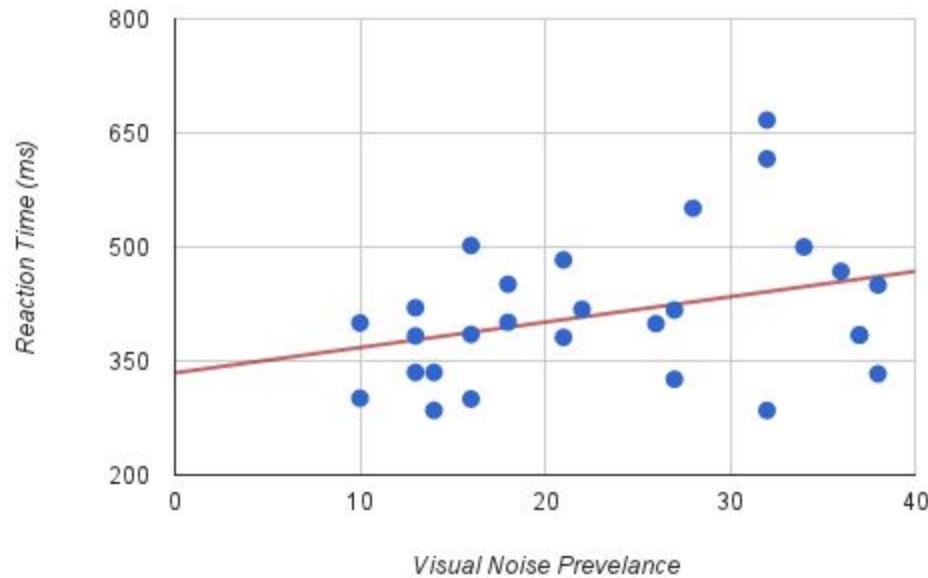
Contrast Results

Effect of reaction time on changing contrast of a visual stimuli

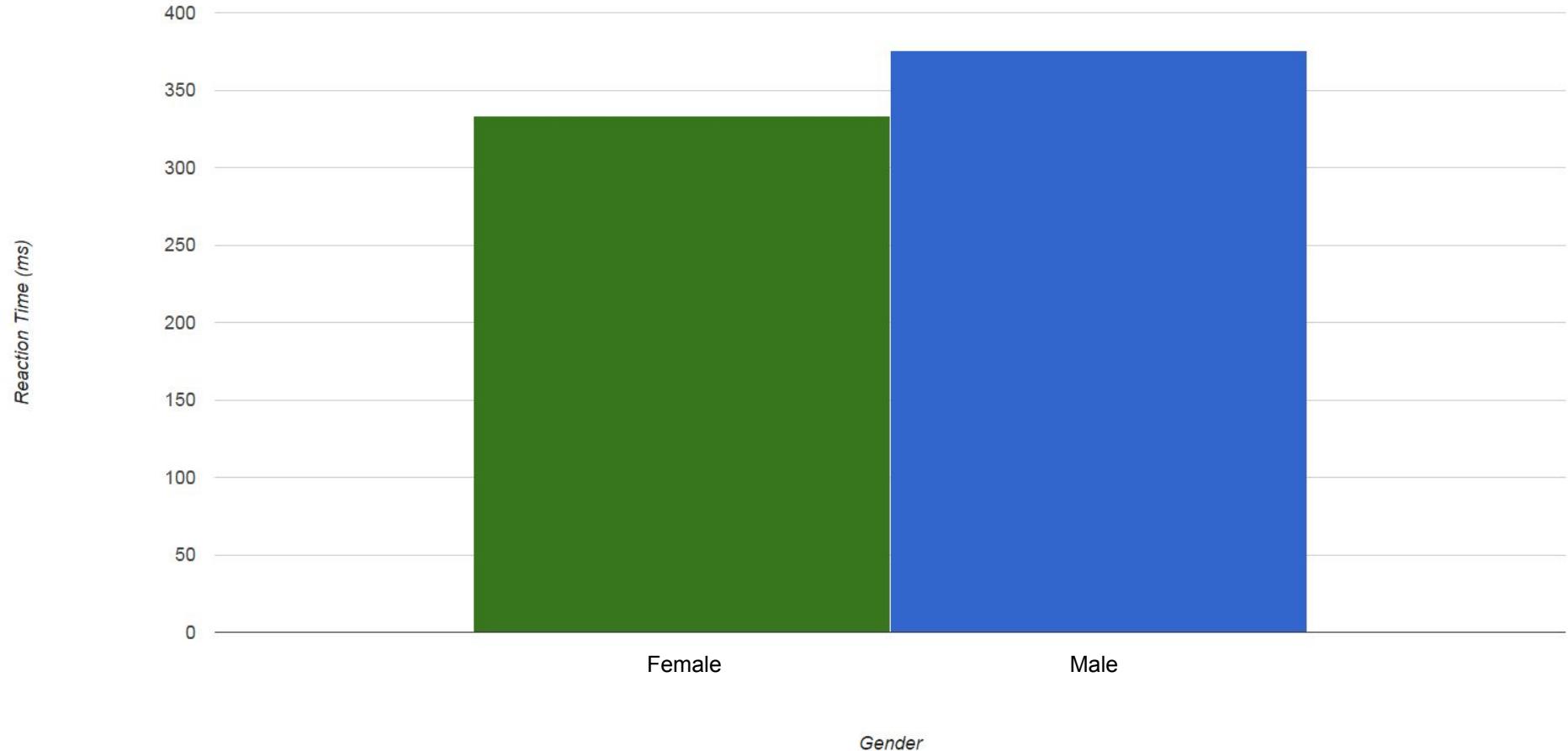


- The results for contrast compared to reaction time shows a very weak negative correlation between the increase in contrast and the increase in reaction time
- This therefore shows the reaction time is slightly decreased as the contrast increases
- While the results show a correlation, it is weak and further testing should be undertaken to make an effective conclusion

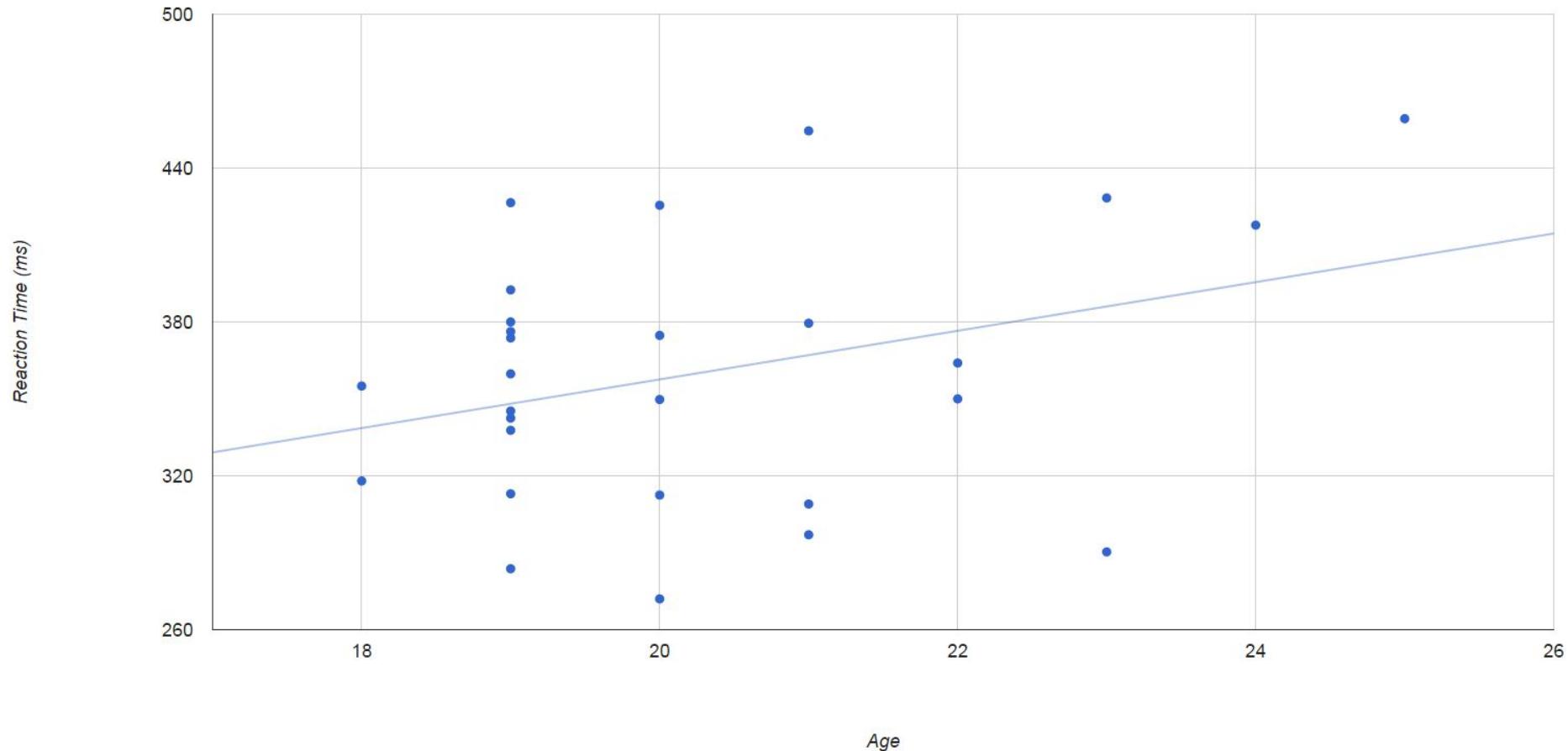
Visual Noise - Results



Relationship between gender and reaction time

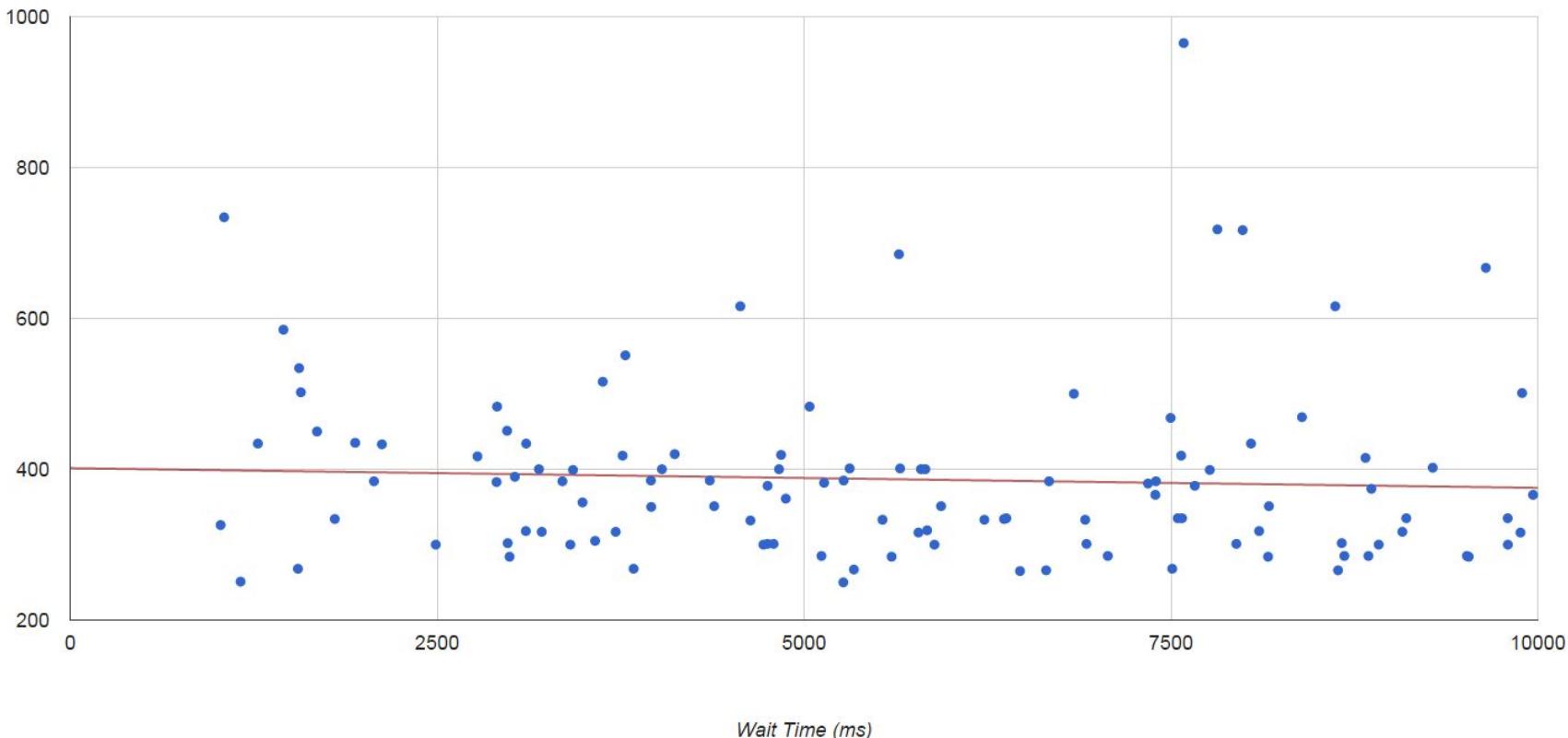


Relationship between age and reaction time



Relationship between wait time and reaction time

Reaction time (ms)



Overall Evaluation

Colour	Blue ($p=0.074$) & Red ($p=0.011$)
Size	No Correlation
Contrast	Neg. Correlation ($p=0.040$)
V. Noise	Pos. Correlation ($p=0.043$)
Gender	Women ($p=0.018$)
Age	Pos. Correlation ($p=0.29$)
Wait time	Neg. Correlation ($p=0.11$)

Overall Evaluation

What went well

- Well controlled variables
- Successful Application (Eliminated human error)
- Group communication - Google docs & Facebook group

What didn't go well

- Screen tilt (IPS display)
- Some participants had poor techniques
- Varying levels of enthusiasm from participants
- Non-native English speakers

Improvements

- Change colour of the pause screen (may have affected results)
- Designate starting hand position (improve internal validity)

- Revision of Visual Noise test

Could have had more ecologically valid representation, such as:

- Animated background
- Varying shapes or objects
- Distraction task

Posner (1980) Letter test

W O R D S



Thank you for listening!

Andrew Reece, Lucy Milson, Felix Rosen,
Matthew Party, Joe Alexander

References:

Lucy:

Kalyanshetti, S. B. (2014). Effect of Colour of Object on Simple Visual Reaction Time in Normal Subjects, 3(1), 96–98. Retrieved from <http://jkimsu.com/jkimsu-vol3no1/JKIMSU>. Vol. 3, No. 1, Jan-June 2014, Page 96-98.pdf

Pinheiro, C., & da Silva, F. M. (2012). Colour, vision and ergonomics. *Work (Reading, Mass.)*, 41 Suppl 1, 5590–3.
doi:10.3233/WOR-2012-0891-5590

Shenvi, D., Balasubamanian, P. A comparative study of visual and auditory reaction times in males and females. *Indian J Physiol Pharmacol* 1994: 38(3):229-231

Venkatesh, D., Ramchandre, D L., Baboon, S., Rajan, B K. Impact of psychological stress, gender and colour on visual response latency. *Indian J physiol Pharmacol* 2002: 46(3):333-337

Andrew:

Kosinski, R. J. (2008). A literature review on reaction time. *Clemson University*, 10.

Gottsdanker, R. (1982). Age and simple reaction time. *Journal of Gerontology*, 37(3), 342-348.