A qualitative Study on Reaction time

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ABSTRACT

Reaction times (RTs) slow and become more variable with age. Research samples are typically small, biased, and of restricted age range. Consequently, little is known about the precise pattern of change, whereas evidence for sex differences is equivocal, so in this experiment we tested the reaction times of males and females using a mathematics test, a visual test and an auditory test. We chose this experiment to see if the people in the college perform well in the test during day or night, also how reaction time varies for the participants from gaming background.

INTRODUCTION

Reaction time is a measure of how quickly an organism can respond to a particular stimulus. Reaction time has been widely studied, as its practical implications may be of great consequence, e.g. a slower than normal reaction time while driving can have grave results. Many factors have been shown to affect reaction times, including age, gender, physical fitness, fatigue, distraction, alcohol, personality type, and whether the stimulus is auditory or visual.

Sensory neurons convert a stimulus into an electro-chemical signal, which flows the length of the sensory neurons, then through a neuron or neurons of the central nervous system, and then through the length of the motor neurons. Generally, motor neurons will cause a muscle to contract or a gland to secrete a substance. Reactions that involve only the receptor, the spinal cord, and the effector, are faster than those which involve processing in the brain. Reactions which only travel to, through, and from the spinal cord are often called spinal reflexes or cord mediated reflexes; withdrawing one's hand from a hot stove is an example of such a reflex. In our case level 1 is 'choice reaction time' and level 2 and 3 are 'simple reaction time' experiment.

Types of Reaction Time Experiments

In 'simple reaction time' experiments, there is only one stimulus and one response. Catching a dropped stick, or hitting a button when a light changes are examples.

In 'recognition reaction time' experiments, there are symbols to respond to and symbols to be ignored. There is still only one correct stimulus and one response. An example would be catching a dropped stick with a word cue, while having to ignore other spoken words which are not cues.

In 'choice reaction time' experiments, there are multiple stimuli and multiple responses. The reaction must correspond to the correct stimulus. Typing a letter which matches a printed letter prompt is an example of this type of experiment.

Average Reaction Time

For about 120 years, the accepted figures for mean simple reaction times for college-age individuals have been about 190 ms (0.19 sec) for light stimuli and about 160 ms for sound stimuli (*Galton, 1899; Fieandt et al., 1956; Welford, 1980; Brebner and Welford, 1980*).

Number of possible valid stimuli

Several investigators have looked at the effect of increasing the number of possible stimuli in

recognition and choice experiments. *Hick (1952)* found that in choice reaction time experiments, response was proportional to $log_2 (N)$, where N is the number of different possible stimuli. In other words, reaction time rises with N, but once N gets large, reaction time no longer increases so much as when N was small. This relationship is called "Hick's Law." *Sternberg (1969)* maintained that in recognition experiments, as the number of items in the memory set increases, the reaction time rises proportionately (that is, proportional to N, not to log N). Reaction times ranged from 420 msec for 1 valid stimulus (such as one letter in symbol recognition) to 630 msec for 6 valid stimuli, increasing by about 40 msec every time another item was added to the memory set. *Nickerson (1972)* reviewed several recognition studies and agreed with these results.

Factors Influencing Reaction Time

Arousal. One of the most investigated factors affecting reaction time is 'arousal' or state of attention, including muscular tension. Reaction time is fastest with an intermediate level of arousal, and deteriorates when the subject is either too relaxed or too tense.

Age. Simple reaction time shortens from infancy into the late 20s, then increases slowly until the 50s and 60s, and then lengthens faster as the person gets into his 70s and beyond (*Welford, 1977; Jevas and Yan, 2001; Luchies et al., 2002; Rose et al., 2002; Der and Deary, 2006*). *Luchies et al. (2002)* also reported that this age effect was more marked for complex reaction time tasks, and *Der and Deary (2006)* concurred. Reaction time also becomes more variable with age (*Hultsch et al., 2002; Gorus et al., 2008*) and with Alzheimer's disease (*Gorus et al., 2008*). MacDonald *et al.* (2008) found that reaction time variability in older adults was usually associated with slower reaction times and worse recognition of stimuli, and suggested that variability might be a useful measure of general neural integrity.

Gender. At the risk of being politically incorrect, in almost every age group, males have faster reaction times than females, and female disadvantage is not reduced by practice. (*Noble et al., 1964; Welford, 1980; Adam et al., 1999; Der and Deary, 2006*).

Left vs. right hand. The hemispheres of the cerebrum are specialized for different tasks. The left hemisphere is regarded as the verbal and logical brain, and the right hemisphere is thought to govern creativity, spatial relations, face recognition, and emotions, among other things. Also, the right hemisphere controls the left hand, and the left hemisphere controls the right hand. This has made researchers think that the left hand should be faster at reaction times involving spatial relationships (such as pointing at a target). The results of *Boulinquez and Boulinquez (2001 and 2002)* all supported this idea. *Dane and Erzurumluoglu (2003)* found that in handball players, the left-handed people were faster than right-handed people when the test involved the left hand, but there was no difference between the reaction times of the right and left handers when using the right hand. Finally, although right-handed male handball players had faster reaction times than right-handed women, there was no such sexual difference between left-handed men and women.

Alcohol. Moskowitz and Fiorentino (2000) review the imparing effects of alcohol on reaction time. Kruisselbrink et al. (2006) found that adult females who drank from one to six cans of beer did not suffer delayed reaction times the next morning, although they made more errors on a choice reaction time task. Hernandez et al. (2007) found that the slowing of reaction time by alcohol was due to a slowing of muscle activation, not muscle action.

Fillmore and Blackburn (2002) found that subjects who had drunk an impairing dose of alcohol reacted faster when they were warned that this was enough alcohol to slow their reaction time. Unwarned subjects who drank suffered more decreased reaction times. However, the warned subjects were also less inhibited and careful in their responses. Even subjects who drank some nonalcoholic beverage and then were warned (falsely) about impairment by alcohol reacted faster than unwarned subjects who drank the same beverage.

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Other factors influencing reaction times :

- Practice and Errors decrease reaction time.
- Fatigue increases reaction time.
- Fasting and Distraction also increases reaction time.
- Faster breathing cycle also improves reaction time.
- Brain injury and sickness increases reaction time.

SIGNIFICANCE

The use of reaction times (RTs) as measures of cognitive functioning has a long history, dating back at least to the 19th century when Galton used them as part of the battery of tests included in his "anthropometric laboratory" (Pearson, 1924). Over a century later, their appeal remains undiminished, particularly in research on aging. There are a number of reasons for this. One is their relative simplicity. RT tasks are simpler to devise and administer than most other cognitive measures or psychometric tests. Nonetheless, they are commonly found to be correlated with other cognitive measures and sometimes to be better predictors of important outcomes. For example, in a recent study (Deary & Der, 2005a), we found RTs to be better predictors of mortality than scores on the Alice Heim 4 Test of General Intelligence (Heim, 1970).

EXPERIMENT

Objective

The purpose of this exercise is to introduce the scientific method, experimental design, and an elementary statistical analysis for calculating reaction time. Using an online application that measures reaction time, the participants are asked to execute, and analyze their reaction time capabilities. The fact that the variable being tested is reaction time introduces an element of competition that heightens student interest. Our objective is to formulate and test hypothesis regarding reaction times and making new hypothesis based on results from the experiment. Independent variables involved in the experiment are gender, age, athletic background and dependent variable is reaction time.

Hypothesis

H0: On an average male have better reaction time then a female.

H1: Athletic males or females have better reaction time than their normal counterparts.

H2: People who play computer games have better reaction time than those who do not.

H3: Visual reaction time is more than auditory reaction time.

H4: Simple reaction time is less than Choice reaction time.

Participants

The experiment was setup with the aim of exploring the relationship between gender, athletic background, and analytical intelligence with reaction time. Most of the participants are fellow students, while some of them are friends. An altogether 28 people participated in the experiment, out of which 20 are males and rest are females. The experiment was conducted with their respective places to eliminate the element of surprise from the exercise. It is to be noted that all the participants were of nearly same age group (i.e. 19- 23 yrs).

Stimulus material

The material used in this experiment was the same as described in the literature i.e. visual and audio. The stimulus material was

presented to all the examinees in the same order. The test was carried out individually. For presentation of the visual stimuli, a computer based game is used which is designed especially for recording visual responses, In this game a green ball appears on the screen after random time interval, participant has to hit the key as soon as he sees the ball. For presentation of auditory stimuli, a separate game is designed, in which a beep of higher note is presented to the participant after random time intervals and he has to hit the key as soon as he hears it.

Procedure

- Experiments contains 3 levels, each level contains a computer game based exercise specifically designed to test a unique skill or stimulus.
- Each participant had to fill his name, gender and athletic background before starting the exercise.
- Before we started recording response time, every participant was given 2 trials for each game, so they could understand the experiment.
- Each participant now plays a game for 10-15 times, and average of output from these trials is stored as the response time of the participant in that particular game, fastest and slowest responses are also noted for each game.
- After each game a rest time 4 minutes is given to the participant to eliminate the residual effect (i.e. boredom, fatigue etc.)
- Games are as follows:
    - Count the Dots (Choice RT)
    - Hit the ball (Visual RT)
    - Press when you hear (Auditory RT)
- Approx. each participant will take 10-15 minutes to complete the exercise.

Allotted task

- A participant first fills his/her name, gender, athletic background in the space provided in the application and a consent form which is digitally verified using their email-id's.
- Each participant will be given 3 minutes relaxation time after completion all the formalities to loosen their stress, also there will be 4 minutes break between subsequent games.

In each level task performed by the participant is as follows:

- *Count the Dots (Choice RT)*
  Random number of dots appears on the screen positioned at random positions. Participants have to calculate all the dots and write it in the space provided in the application as soon as possible.
- *Hit the ball (Visual RT)*
  A green ball will appear at random intervals on the screen. Participant has to click the ball as fast as possible and the time taken to click it will be noted as the response time for that trial. And average of all the trails will give average for this game.
- *Press when you hear (Auditory RT)*
  In this particular level a participant will hear a higher note after random intervals of time and his/ her task to hit the space bar as soon as he/she hears it.

MEASURMENT

RT was measured using a simple Windows based machine. Five keys needed for the experiment are 4,5,6,7 for Level 1 and SPACE BAR for the rest of the levels. In Level 2 and 3 the index finger of the respondent's preferred hand rests on this key, and the respondent is told to press it as quickly as possible after stimuli is stimulated. The keys labelled 4, 5, 6 and 7 are used for the choice RT task. In part 1, the respondent rests the index and middle finger of each hand on the keys and presses the corresponding key when one of the four digits appears in the display. There were 2 practice trials and 10 test trials. In the test trail, respondent is allowed get acquaintance with the game. For both tasks, the time between the response and the display of the next digit varied randomly. Application does not store the results of individual trials but calculates the mean and standard deviation of the test trials in milliseconds. For the choice RT task, the mean and standard deviation of the only correct and responses were recorded, and the number of errors was also recorded in level 1. The primary focus of this study was on these measures: the average and accuracy of the choice RTs and those of the responses to the simple RT task.

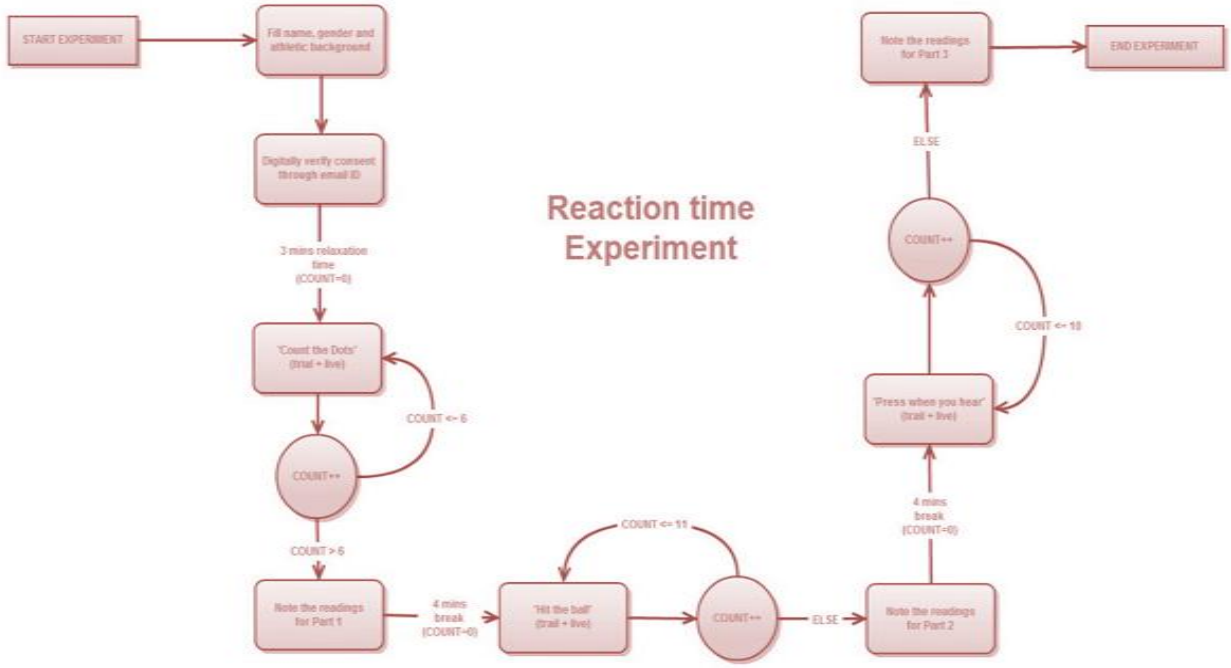
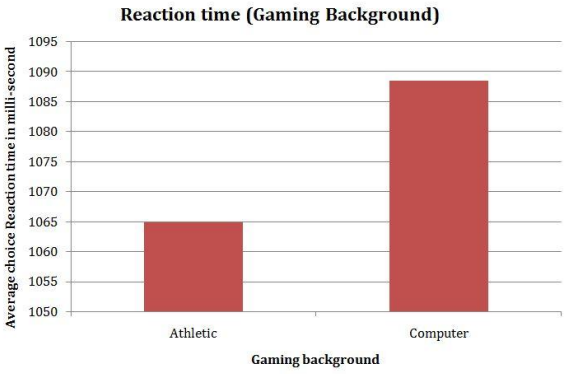


Fig 1.1: Flow chart representation of the experiment

RESULTS AND DISSCUSSION

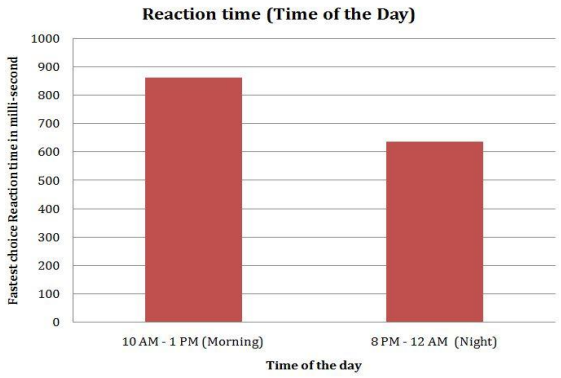
Out of the 28 respondents who took part in the experiment 8 were females and rest males. Due to low male by female ratio, we were unable to analyze any gender based variation in RT. Mostly all of the participants were form the college, so there may be results contrary to the literature. You can find detailed data table in Appendix I.

While comparing two types of participant, athletes and those who play computer games, athletes came out to be with better performance which is in line with previous such studies. This can be attributed to the fact that they have better development of a complex group of cognitive, fine motor, gross motor, eye-hand coordination and fitness skills. Also sport training provides improvements in other psychomotor performance variables that can be translated to other non-sport multitasking setting. Participant with an athletic background are use to surprising situations (in real time gaming most of the action are random), so their mind is habitual with these kinds of situation and adapt better, So when they are asked to participate in the experiment , they saved time by reducing the element of surprise In IIIT most of the students have a tendency to Secondly they have better muscle movements, so they respond relatively faster while passing their response through computer. However second reason is also valid for those who play computer games. Hence athletes have better reaction time then computer gamers and gamers have even better reaction time than a normal male or female.



The fact that we humans possess a 'biological clock' is well known. During the night our body works differently from the daytime: we need sleep, at a certain moment it is nearly impossible to stay awake. Accidents happen very often in late night or early morning, a time at which a human being should be sleeping (Chernobyl, Exxon Valdez, etc). But we happen to found a different trend in IIIT i.e. we had better reaction times in night.

remain awake late in the night which causes acute sleep deprivation, the need for sleep is greater after a late night routine, and the subject feels sleepier in morning time. As a result his motor activities, analytical skills etc. all are affected which leads to slower response by participants in the day than in the night. Moreover at night in urban areas, vision operates in the mesopic range, so there is mixed rod-cone activation. The few existing data suggest that reaction time sharply increases as the rods become the primary photoreceptor.



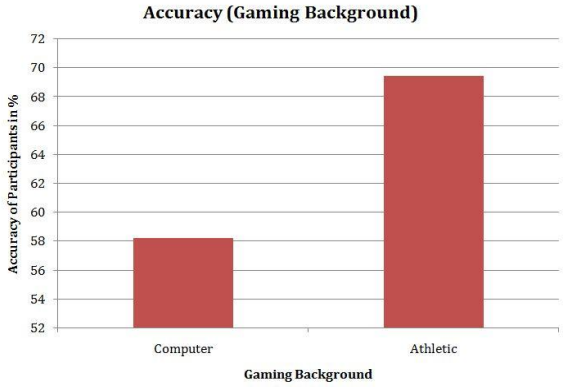
Our study also revealed that computer gamers have better accuracy than a normal male or female. This result is in accordance with the previous studies.

In 2010, following the discovery that video games can help you see more shades of grey than a Suburban full of soccer fans, cognitive scientists from the University of Rochester also discovered that playing action video games trains people to make correct decisions faster.

Researchers found that video game players "develop a heightened sensitivity to what is going on around them, and this benefit doesn't just make them better at playing video games, but improves a wide variety of general skills that can help with everyday activities like multitasking, driving, reading small print, keeping track of friends in a crowd, and navigating around town."

People, you see, make decisions based on probabilities that they are constantly calculating and recalculating in their heads. The process is called probabilistic inference; the brain stockpiles small pieces of visual or auditory information until it has enough data for a person to make what they perceive to be an accurate decision.

They also found that action video game players' brains are actually more efficient collectors of visual and auditory information. Due to this they demonstrated an ability to amass the details needed to arrive at a correct decision faster than non-gamers.



Study also showed that choice reaction time is slower than simple reaction time with better performance results in case of auditory than visual simple reaction time test.

In SRT tasks, the response is the same on every trial. The subject can, therefore, pre-programme the response which only needs to be initiated when the occurrence of the imperative stimulus is registered. Given that the stimulus is also invariant, identification and encoding of the stimulus are not necessary. While CRT tasks involve a process of decision making, and this is responsible for the delay between SRT and CRT tasks.

The first scientist to measure reaction time in the laboratory was Franciscus Donders. Donders found that simple reaction time is shorter than recognition reaction time, and that choice reaction time is longer than both. Donders also devised a subtraction method to analyze the time it took for mental operations to take place. By subtracting simple reaction time from choice reaction time, for example, it is possible to calculate how much time is needed to make the connection.

The basic idea of the subtraction method for reaction time is that a measure of the duration of a particular process can be found by obtaining two measurements of time that include the process and subtracting one from the other. The method applies to situations in which time can be directly

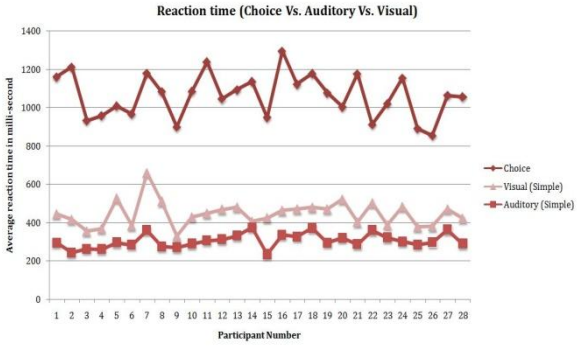
measured for the completion of a physically inseparable series of events that each take time but cannot be measured individually. The challenge solved by the subtraction method is to measure the time taken by one or more of these distinct but inseparable events. Most importantly it showed that there is significant amount of difference between CRT and SRT and also calculated that delay.

Donders proposed that the time for the choice reaction task was composed of a simple reaction time (measured in the first task) and a stimulus discrimination time (measured in the second task) as well as the time for making a choice.

Simple Reaction Time	=	Signal Perception + Motor Response
Choice Reaction Time	=	Signal Perception + Stimulus Discrimination + Response Choice + Motor Response

While comparing two types of stimuli, VRT was more than ART which is in line with previous such studies. Reaction time is dependent on several factors like arrival of the stimulus at the sensory organ, conversion of the stimulus by the sensory organ to a neural signal, neural transmissions and processing, muscular activation, soft tissue compliance, and the selection of an external measurement parameter (Pain & Hibbs). Researches by Kemp, show that an auditory stimulus takes only 8-10 milliseconds to reach the brain, but on the other hand, a visual stimulus takes 20-40 milliseconds. This implies that the faster the stimulus reaches the motor cortex; faster will be the reaction time to the stimulus. Therefore since the auditory stimulus reaches the cortex faster than the visual stimulus, the auditory reaction time is faster than the visual reaction time.

In other words vision takes 20–40 ms to travel in visual pathway while sound takes just 8–10 ms to travel in auditory pathway. This time difference is observed in both the varieties of test. Adjoining figure shows reaction time for audio and visual SRT tasks and CRT task.



FUTURE RESEARCH

A priority for future research is to replicate interactions between personality and reaction time in people with brain injuries or autism and find specific mechanisms. Stratification of population data on cognitive health by personality and reaction time could improve strategies for identifying those at greater risk of cognitive decline.

CONCLUSION

From above study it is clear that VRT is more than ART. Simple RT is less than Choice RT. Due to the fact that decision making came into play. It can also be concluded that simple reaction time is faster for auditory stimuli compared to visual stimuli. Auditory stimuli has

- The fastest conduction time to the motor cortex.
- Fast processing time in the auditory cortex.
- Therefore faster reaction time and quick muscle contraction.

Also people in IIIT have better efficiency while working during night than during day.

ACKNOWLEDGEMENT

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[24] Cognitive Fun games
http://cognitivefun.net

APPENDIX I

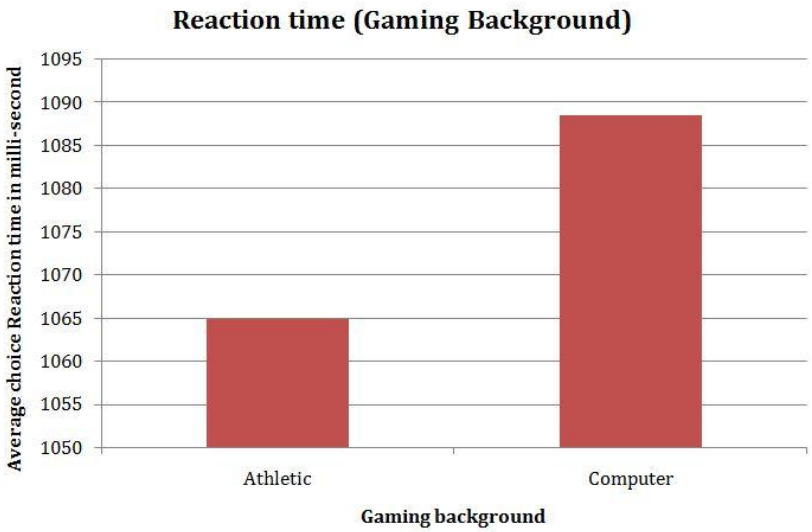
Data Table

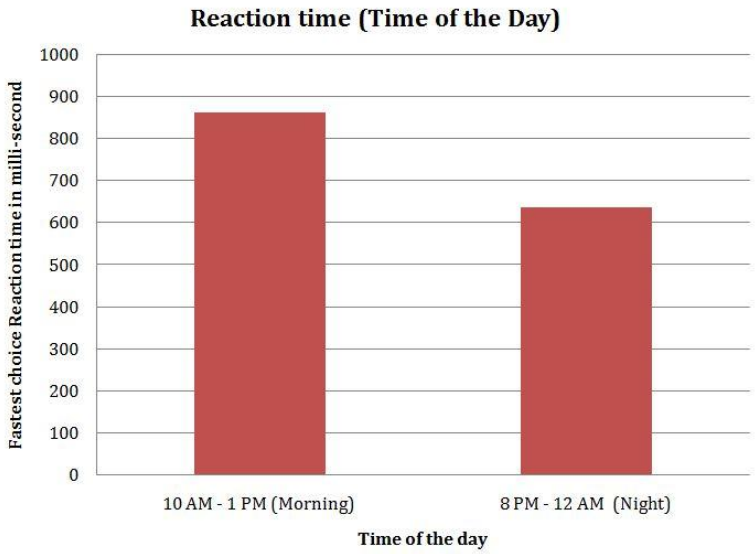
"Reaction Time" - Cognitive Science Experiment (2012)

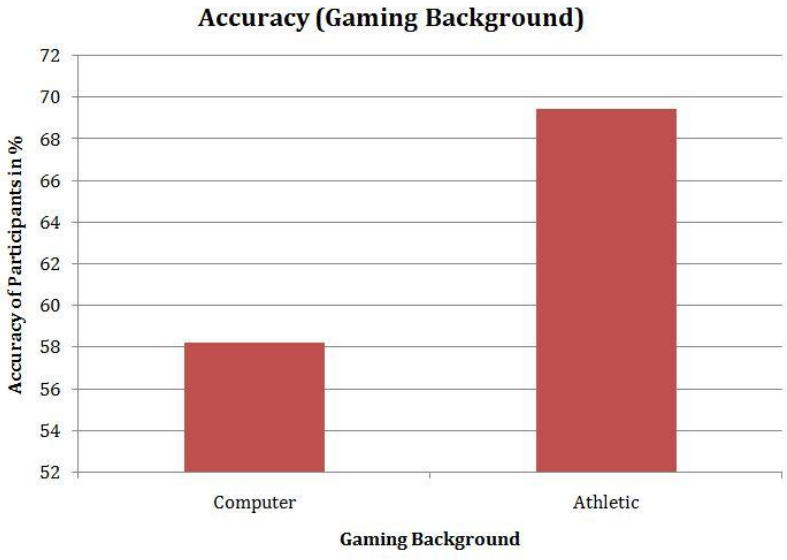
Sno.	Name	G1F (ms)	G1S (ms)	G1Av (ms)	G1Ac (%)	G2F (ms)	G2S (ms)	G2Av (ms)	G3F (ms)	G3S (ms)	G3Av (ms)
1	Abhishek	750	1290	891.84	60	235	375.99	285.79	338	433	378.6
2	Aditya	714.99	1500	1160.72	55.55	244	423	295.4	362	580	445.6
3	Deep	993	1500	1212.09	36.36	227	292	244.59	334	471	416.4
4	Indrajit	665.99	1218	933.69	80	236	306	263.8	317	402	356.2
5	Jaya	757	1408	1064.63	73.68	329	433	363.4	426.99	544	471.99
6	Kshitij	856	1500	1094.36	90.9	280	490.99	332.19	411	607.99	481.79
7	Lakshya	779	1500	1154.21	64.28	236	444.99	302	415	568	484.14
8	Manuja	760	1487	1078.22	76.43	275	367	296	402	520	472.14
9	Namra	810	1450.99	1136.64	85.71	325	461	376.16	326	583.99	406.66
10	Naveen	558	1500	959.27	45.45	221.99	332	262.39	337	405	369.6
11	Navneet	710.99	1328	855.79	40	214.99	461	296.19	360	411	380.8
12	Neelima	660	1500	1004.6	68.18	225.43	389	321.14	402.32	660	523.12
13	Nikita	659	1435.85	1056.68	72.12	286.15	442	290.16	416.56	441.1	423.15
14	Nitin	778	1500	1008.72	45.45	231	474.99	296.8	385	710	527.6
15	Pallavi	660	1495	1176.89	48	242	562	287.45	362	467	403.44
16	Praneetha	657	1500	913.8	75	295	441	360.6	440	582	504.39
17	Pratyush	714	1339.99	967.79	80	265.99	316.99	284.99	366	448	384.4
18	Qamar	39.99	1500	1179.93	53.33	217	720	361.22	421.99	1599.99	661.16
19	Rishabh	745.99	1347	949.3	60	221.99	276	235.79	347.99	561	424.79
20	Sana	634	1469	1022.45	73.47	236	410	322.14	347.66	402.23	389.17
21	Sanket	825	1500	1296.19	66.66	276	578	336.5	442	487	464.2
22	Shubhank	850	1459.99	1083.46	76.92	245	318	275.99	402	711	510.92
23	Shubham	731	1153	900.22	77.77	254	309	271.2	302	343	330.99
24	Siddharth	604	1500	1086.09	54.54	236	382.99	290.2	370.43	548	430.28
25	Siladitya	841	1459	1238.79	60	246	477	307.4	386.99	607	448.6
26	Soumen	784	1500	1122.81	81.81	314	347	327.5	408	533	472.2
27	Supriya	690	1500	1046.76	61.53	276	354	312.99	449	483	470.4
28	Vinay	806.75	1500	1178.57	84.61	310.76	401	372.65	422.84	541.38	480.13

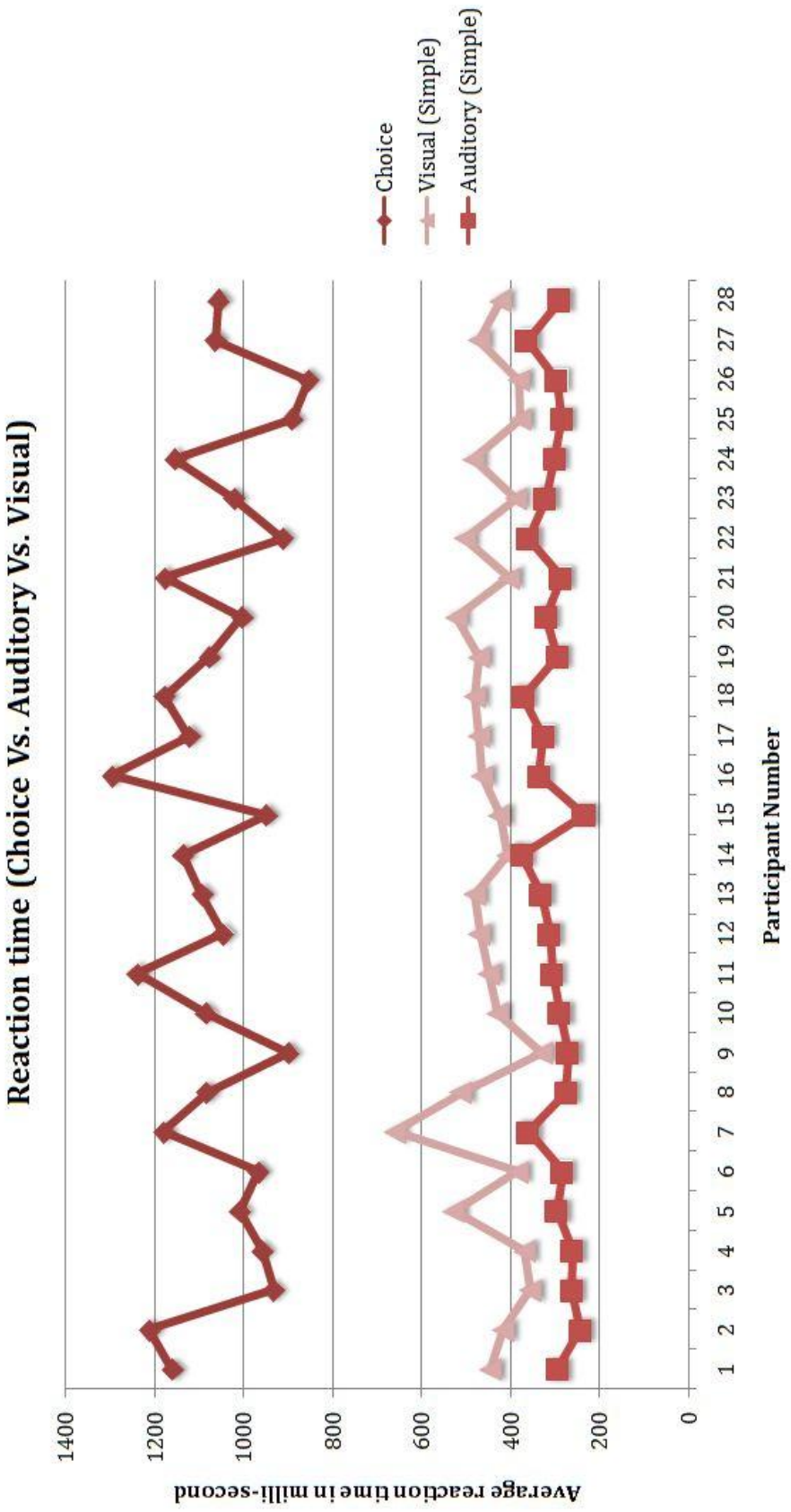
Note: *GXF, GXS, GXAv represents fastest, slowest and average response time in milli-seconds respectively and GXAc represents accuracy in % in Xth game. where as X equals 1 represents 'Count the Dots', 2 represents 'Hit the ball' and 3 represents 'Press when you hear'*

Graphical Results








Reaction time (Choice Vs. Auditory Vs. Visual)
Choice
Visual (Simple)
Auditory (Simple)
Average reaction time in milli-second
1400
1200
1000
800
600
400
200
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Participant Number

Referred Papers and Articles

- *A Study of Correlation between Auditory and Visual Reaction Time in Healthy Adults*
  (Jayesh Solanki, Naisargi Joshi, Chinmay Shah, H.B Mehta, P.A Gokhle)
  http://ijmedph.org/sites/default/files/IJMEDPH_2_2_8.pdf

- *Effective analysis of reaction time data*
  (Robert Whelan, University College Dublin)
  http://opensiuc.lib.siu.edu/cgi/viewcontent.cgi?article=1077&context=tpr

- Analyzing Reaction Times
  (R. Harald BAAYEN, Department of Linguistics, University of Alberta, Canada and Petar MILIN ,Department of Psychology, University of Novi Sad, Serbia Laboratory for Experimental Psychology, University of Belgrade, Serbia)
  http://www.ualberta.ca/~baayen/publications/BaayenMilin2010.pdf

- Age and Sex Differences in Reaction Time in Adulthood: Results From the United Kingdom Health and Lifestyle Survey
  (Geoff Der, University of Glasgow and Ian J. Deary, University of Edinburgh)
  http://www.utoledo.edu/eduhshs/depts/kinesiology/pdfs/Reaction-Time_article.pdf