Investigating the effect of age on reaction time performance

Key:

Age group 1- 10 to 11 years old (Children)

Age group 2- 18 to 19 years old (Teens)

Age group 3- 44 to 45 years old (Adults)

Age group 4- 73 to 76 years old (Seniors)

Hypothesis:

The reaction time performance will be the **best/fastest** in **teens** *(Age Group 2)*. In **adults** *(Age Group 3)*, it will be **slightly slower**, due to the increased age of the participants. It will **worsen** even more in **children** *(Age Group 1)*, due to the incomplete development of the participants. And lastly, **seniors** *(Age Group 4)* will have the **worst** reaction time performance, due to the advanced age of the participants.

Introduction:

The age of a person is the length of time that the individual has lived. At the beginning of a person's life, ageing has numerous positive effects such as improved motor skills or cognitive functioning. However, after a certain point, **ageing** begins to have **detrimental effects** such as hearing loss, chronic pain, or dementia.[1] More specifically, the physiological decline of the human body includes, **decreasing lung capacity**, **decreasing cardiac output**, **decreasing bone density** and a general **weakening** of the **heart**, accompanied by **arteriosclerosis**.[2] **Mobility** is also adversely affected because of the negative impacts of age on components of fitness, such as **decreased agility/speed** and the reduction of muscle fibres.[3] **Fast-twitch muscle fibres** especially, which is relevant to this study. Thus, with all these various effects ageing can have, it is quite sensible to assume that it will have an impact on **reaction time performance**.

[1] A Quick Look at Reflexes - Health Encyclopedia - University of Rochester Medical Center
[2] Age-related physiological changes and their clinical significance - PubMed (nih.gov)
[3] Age-related physiological changes and their clinical significance - PubMed (nih.gov)

Reaction time performance is the measure of how quickly a person responds to a particular stimulus. A study conducted by the University of Rochester has proven that "reflexes do slow with age".[4] It is caused by the physical changes in **nerve fibres** and the **loss of cells** in the parts of the brain involved in motor control.[5] According to the Thompson et al (2014) study, the researchers have discovered that the brain's reaction time performance begins to deteriorate at **age 24**[6] and the decline is relatively slow but steady. After the peak, reaction time performance **declines 4-10 milliseconds per year** depending on the type of testing. Even though, this decline can be slowed by **good nutrition, good sleep**, **cognitive stimulation,** and regular **exercise.**[7] A **slow** and **steady decline** in reaction time performance after the age of 24 is **unavoidable**.[8]

From my perspective, I am really interested in exploring these potential effects, mainly due to my experience with FPS (first-person shooter) or e-sport games, where reaction time performance is **extremely important**. With the vast majority of professional players reaching their **peak** at around **24-25 years of age**. In this technological era, researchers have utilised video games to try to **improve reaction time performance** and better understand the human brain or its cognitive functions. Mainly because video games have proven to improve **multitasking**, **attention**, and **object tracking**. These games have been a huge part of my life and I have always strived to be the best. Reaction time performance was a big part of this goal and that is the reason why it has always intrigued me. As a teenager, I have played a **competitive game** called CS:GO, participated in multiple **online tournaments** and managed to reach the **top rank** in the game called "Global Elite". Even though I no longer have enough time to play competitively, I am still **interested** in what makes a good **competitive player** and reaction times performance appears to be an absolutely crucial aspect of this equation. Thus, I am very passionate about this study because the results might give us more definitive conclusions, as to when the reaction time performance **peaks** and how **rapidly it deteriorates.** All this information might then be applied in a variety of sports, for instance, e-sports (CS:GO) or even F1 racing.

[4] A Quick Look at Reflexes - Health Encyclopedia - University of Rochester Medical Center
[5] A Quick Look at Reflexes - Health Encyclopedia - University of Rochester Medical Center
[6] Your brain's reaction time peaks at age 24, study finds | PBS NewsHour
[7] How much does reaction time declines with age? (gofullbuild.com)
[8] How much does reaction time declines with age? (gofullbuild.com)

Aim:

To evaluate the **impact of age**, on the **reaction time performance** (measured in ms, ±1 ms) in 16 subjects **ranging in age** from 10 to 76 years of age.

Dependent variable:

Reaction time, measured using an online reaction time test*:

Online Reaction Time Test (washington.edu)

Measured in ms, ± 1 ms.

*Participants must press the “Space Bar” as soon as the red-light changes to a green light on the traffic light, which is visible on the screen. That is how the computer measures the participant’s reaction time performance.

Independent variable:

Age of the participants.

There are 4 different age groups:

1. 10-11 years old (Children)
2. 18-19 years old (Teens)
3. 44-45 years old (Adults)
4. 73-76 years old (Seniors)

Confounding Variables:

- The **psychological state** of the test subject. This is acknowledged, but we cannot influence how someone is feeling or how their day has gone.
- **Location-** the tests were not all carried out in the same room
    - some of the tests were performed in school (Teens) and others at my home location (Children, Adults, Seniors)
- **Gender-** the testing groups did not have identical male/female ratios (convenience sampling was utilised)
    - **Children-** 4 males / 0 females
    - **Teens-** 4 males / 0 females

- **Adults-** 2 males / 2 females
- **Seniors-** 2 males / 2 females

Controlled variables:

What?	How is it controlled?	Why does it need to be controlled?
Recording of each trial and data collection	The participants will all use the same testing website, which will measure and record their performance.	This ensures that there will be no inconsistencies caused by the testing website or data collection method.
Practice effect	To negate any change that may occur due to the lack of practice, each participant will complete 5 trials that are not recorded.	This ensures that all participants will be similarly familiar with the website and the testing process.
Testing device	All participants will use the same device for testing- Dell XPS 13 9380.	This ensures that there will be no inconsistencies caused by the testing device.
Seated position	All participants will be in an identical seated position during the experiment.	This allows participants to remain calm and appropriately relaxed.
Distractions	During the experiment, all participants will be alone in a closed room, to avoid any unwanted distractions.	This ensures that there will be no inconsistencies caused by external interruptions.

Experimental design / methodology:

Sample-

Age group 1- 10 to 11 years old

Age group 2- 18 to 19 years old

Age group 3- 44 to 45 years old

Age group 4- 73 to 76 years old

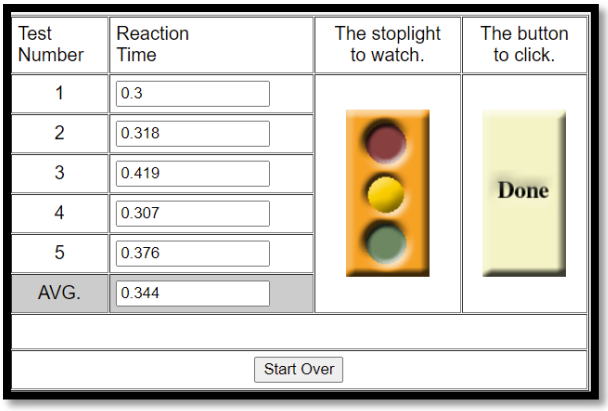
Equipment needed-

- Testing device- Dell XPS 13 9380
- Access to internet
- Empty room with a chair and a table

Testing procedure-

1. Find suitable subjects, based on their age, that fit the predetermined age groups.
2. Choose the first test subject, approach the test subject, and explain the experiment process to the test subject.
3. Ask the test subject to fill in the Microsoft form, where they also give their written consent. (https://forms.office.com/r/EnYH4y1BD1)[9]
4. If the answers to the Microsoft form allow for it, proceed with the experiment.
5. The first test subject, from Age Group 1, will be isolated and seated in an empty room, where all the other necessary information regarding the experiment will be explained.
6. Next, they will proceed to complete 5 practice trials to familiarise themselves with the program and any additional questions will be answered.

[9] Appendix- full form



7. Then, the room will be emptied, and the participant will complete the actual reaction time performance test independently.
8. After completing the test, the participant takes a screenshot of the results, by pressing a button on the keyboard.
9. Next, the participant proceeds to complete the test again. This results in 10 pieces of data from each participant.
10. The website will record and collect all the crucial reaction time performance data.
11. After securing the data, there will be a short interaction with the participant and to thank them for their participation.
12. The remaining participants from Age Group 1 will go through steps 3 to 9.
13. Next, the test subjects from Age Group 2 will go through steps 3 to 9.
14. Then, the test subjects from Age Group 3 will go through steps 3 to 9.
15. Lastly, the test subjects from Age Group 4 will go through steps 3 to 9.
16. In the end, all the recorded data will be inputted into an excel spreadsheet and the experimental part of the study will be concluded as completed.

Observations:

- Subject alertness differed since the trials were conducted at different times of the day.
- Younger participants understood how the test worked much quicker than older participants.
- Older participants found it more difficult to stay fully focused on the screen throughout the experiment, resulting in uncharacteristically long reaction times (outliers or anomalies).

Table 1 and Key to Table 1:

Table displaying the reaction times (±1ms) of 16 participants from the 4 different age groups																
	Age group															
	1 (Child)				2 (Teen)				3 (Adult)				4 (Senior)			
	Participant															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	359	350	362	281	263	236	272	220	274	266	328	306	264	290	318	342
	289	437	284	296	253	266	263	235	295	230	264	287	265	298	328	422
	468	286	316	327	283	259	262	283	260	253	308	238	599	282	376	358
	312	274	291	322	267	264	258	287	250	254	275	357	276	298	385	348
	330	296	315	441	277	311	257	241	254	265	252	225	247	427	340	339
	329	406	297	401	246	275	267	234	253	236	305	258	267	297	371	586
	358	304	342	334	274	260	260	249	264	248	259	301	249	283	352	347
	425	313	293	286	294	291	267	239	258	257	302	284	268	282	323	323
	336	323	307	365	269	268	261	271	271	259	267	264	578	296	372	336
	307	294	330	285	255	244	259	264	288	263	288	244	291	439	335	356
Average	351.30	328.30	313.70	333.80	268.10	267.40	262.60	252.30	266.70	253.10	284.80	276.40	330.40	319.20	350.00	375.70
Mean	331.78				262.60				270.25				343.83			
Standard deviation	48.76				17.93				27.02				84.77			
Percentage Change (over time)	Starting age				20.85%				-2.91%				-27.22%			

Age group 1- 10 to 11 years old

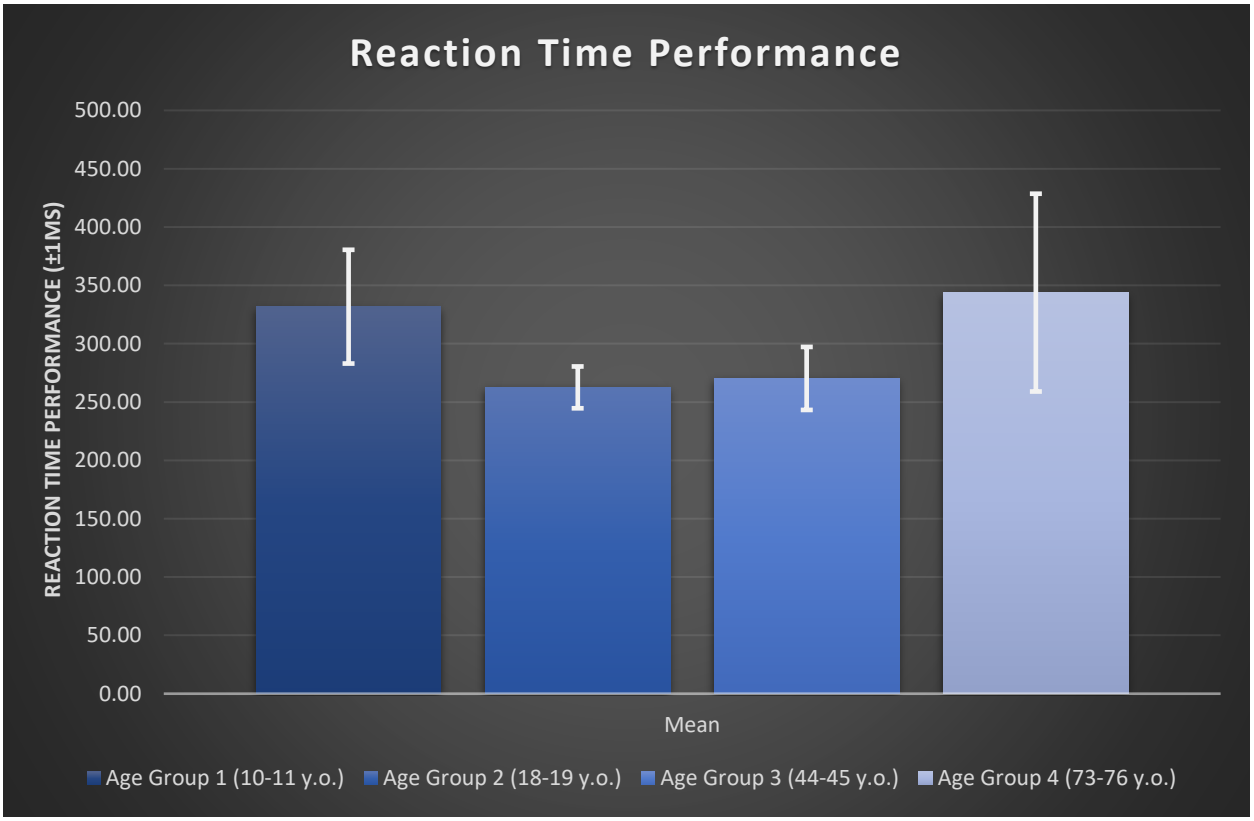
Age group 2- 18 to 19 years old

Age group 3- 44 to 45 years old

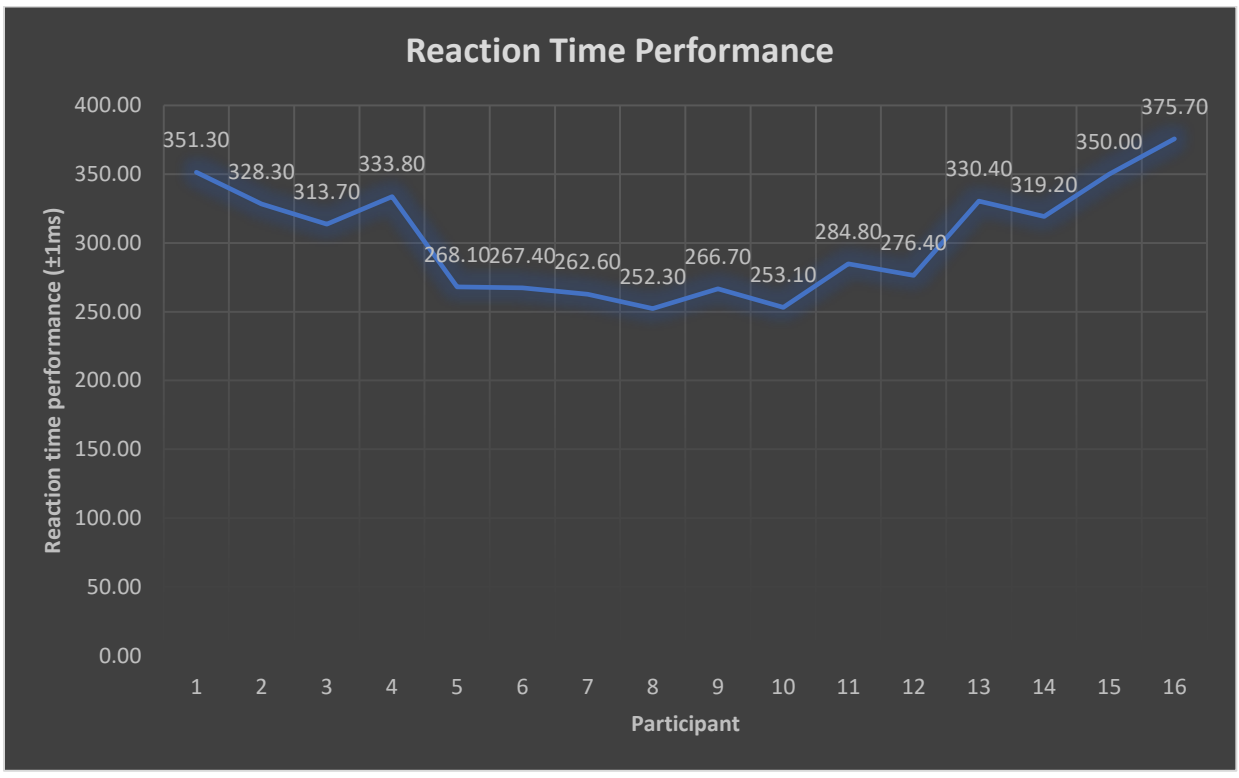
Age group 4- 73 to 76 years old

- The data highlighted in yellow are outliers and they were the result of inattention rather than actual reaction time. Nevertheless, they were included in the calculations and graphs, because they indicate that participants from the oldest group had a harder time focusing on the screen continuously.
- Average is calculated for each participant.
- Mean and Standard Deviation are calculated for each age group.

Graph 1:



Graph 2:



Analysis and conclusion:

The data was entered into a t-test calculator (t Test results (graphpad.com)) with the full results available in the appendix.[10]

The **t-test** suggests that the results between Age Group 1/Age Group 2 and Age Group 3/Age Group 4 are "extremely statistically significant". Meaning that they are considerable and can be utilised to make conclusions. However, the **t-test** also states that the differences between Age Group 1/Age Group 4 and Age Group 2/Age Group 3 are "**not statistically significant**". Meaning that the differences between these two groups are not large enough to influence conclusions. This statistical insignificance stems from the fact that reaction times do not deteriorate that rapidly between the ages of 18 and 45 (Age Group 2 - Age Group 3). Similarly, the **lack of cognitive development** in Age Group 1 and the **age-induced deterioration** of reaction time performance in Age Group 4 result in approximately **similar** reaction time performance.

Additionally, in the raw data, there were multiple, **anomalies or outliers**, all in Age Group 4. These 5 anomalies occurred in the group with the oldest participants. This is the case, due to the inability of older people to continuously focus on the computer screen and produce consistently good results. I have been informed about this by 3 out of the 4 older age participants, in the post-test interaction. Nevertheless, I chose to ***not*** exclude these outliers, because I believe that this inattention is a direct result of advanced age and thus is significant for this study. Furthermore, the better the overall group performed, according to the mean, the lower the standard deviation. Implying that people with **better reaction** time performance also had **more consistent** results.

The results have shown that the average reaction time was the shortest in Age Group 2 (Teen), followed by Age Group 3 (Adult), then Age Group 1 (Child) and lastly the longest average reaction time occurred in Age Group 4 (Senior). The analysis of the data shows that the mean reaction time in Age Group 2 was 262.6 ms; the mean value in Age Group 3 was 270.25 ms; then the mean value in Age Group 1 was 331.78 ms and lastly the mean reaction time in Age Group 4 was 343.83 ms. This supports my hypothesis and implies that age does indeed influence reaction time performance. As the child develops, reaction time

[10] Appendix

performance improves, by 20.85% between the ages of 11 and 19 years old. Nevertheless, after a certain age, in this study,19 years old, the reaction time performance worsens. This deterioration is not very drastic, only 2.19% between the ages of 19 and 45 years old. This is in accordance with other prior studies. Still, the largest decrease, of 27.22%, comes between the ages of 45 and 76 years old. Thus, it can be concluded that beyond a certain point, ageing has a **negative effect** on reaction time performance. This is caused by the slowed reflexes, which are the result of physical changes in nerve fibres and the parts of the brain involved in motor control lose cells over time. This deterioration appears to worsen exponentially over time.

Although the processed data supports this conclusion, it is important to consider the statistical significance of the data. The statistical significance indicated that there is no real difference between Age Group 1/Age Group 4 and Age Group 2/Age Group 3. Thus, children and seniors have very similar reaction time performance, even though there is the largest age gap between them. And similarly, the reaction time performance of teens and adults is also very comparable, supposedly because the **negative effects** of age have **not manifested** substantially enough.

Evaluation:

All in all, the results were reasonably reliable, even though the standard deviation in Age Group 4 was significantly larger, at 84.77 ms. This was due to the multiple outliers present in this group, caused by the inability of the older participants to continuously pay attention to the screen and perform **consistently**. Nevertheless, these outliers were still used in calculations and graphs because this inattention was a direct result of ageing. Moreover, since there were essentially 160 sets of data from 16 different subjects, the validity and reliability of the results were not compromised drastically. However, there were a few other **limitations** that affected the results.

<u>Factors that influenced the results:</u>

- Outlier results due to the inattention of older participants. This was caused by the advanced age of the participants and the participants simply took longer to notice the stimuli (traffic light change) in some cases.

- Time of the day- the tests were not conducted at the same time of the day, which may have affected the participant alertness in the test. When the test was conducted in the morning, the participants may have been more alert and less tired, than when it was conducted in the late afternoon.
- Gender- even though most of the participants were male, there were a few female participants as well. This is just another variable that was present in this experiment and perhaps one gender has generally better reaction times than the other gender. Since the groups did not all have an equal number of males and females in them, this is a factor that may have affected the results.

Although the resultant **outcome** is approximately **consistent** with the **hypothesis**, to **improve** the **accuracy** and **conclusiveness** of this study **larger sample** size should be utilised. More **structure** should ensure that all candidates are tested on the **same day** and did not have access to any **substances**, which could stimulate receptors, negatively influencing result validity. Moreover, I could have added one or two more age groups in order to receive more comprehensive and **definitive results**. One of these groups could have been around 30 years of age and the second one around 60 years of age. Furthermore, the general **state of mind** of the individual and the diet were quite difficult to control. For instance, the individual might have been **upset** by some events that happened earlier in the day, which may have affected the results. Similarly, the results may have been affected by the food or liquids that the participant consumed earlier in the day.

Limitation	**Variable**	**Improvement**
The older participants were unable to continuously pay attention to the screen and perform consistently.	Inattention	It is a normal part of the testing process when the participants are of advanced age.

Diet- subjects might have taken in food or liquids that may have affected the results.	Diet	State what the participants are not allowed to eat/drink before testing.
The tests were not conducted at the same time of the day, which may have influenced the alertness/ tiredness of the participants.	Time of day	Set a predetermined time for testing; all tests will be conducted at the same time of the day, e.g., at 11.00 am.
All groups did not have the same gender distribution of participants.	Gender	Either all participants must be of the same gender, or the same ratio of males/females must be used in each testing group.

Bibliography

1. Allen, J. (2002). *Online Reaction Time Test*. [online] Washington.edu. Available at: https://faculty.washington.edu/chudler/java/redgreen.html [Accessed 27 May. 2021].
2. Blank-Rochester, A. (2013). *Video games speed up reaction time - Futurity*. [online] Futurity. Available at: https://www.futurity.org/video-games-speed-up-reaction-time/ [Accessed 1 Dec. 2021].
3. gofullbuild.com. (n.d.). *How much does reaction time declines with age?* [online] Available at: https://gofullbuild.com/post/how-much-does-reaction-time-declines-with-age/ [Accessed 1 Dec. 2021].
4. Gr, B. and Je, S. (1981). *Age-related Physiological Changes and Their Clinical Significance*. [online] The Western journal of medicine. Available at: https://pubmed.ncbi.nlm.nih.gov/7336713/ [Accessed 30 Nov. 2021].
5. Hanrahan, J. and Jasmin, L. (2019). *A Quick Look at Reflexes - Health Encyclopedia - University of Rochester Medical Center*. [online] Rochester.edu. Available at: https://www.urmc.rochester.edu/encyclopedia/content.aspx?ContentTypeID=1&ContentID=562 [Accessed 27 May. 2021].
6. IB SEHS NOTES. (2016). *IB SEHS NOTES*. [online] Available at: https://ibsehsnotes.wordpress.com/ [Accessed 27 May. 2021].
7. Matthew Stewart, Roger Adams, Albert Alonso, Blake Van Koesveld, Scott Campbell. Warm-up or stretch as preparation for sprint performance? Journal of Science and Medicine in Sport (2007)10,403—410 [Accessed 27 May. 2021].
8. PBS NewsHour. (2014). *Your brain's reaction time peaks at age 24, study finds*. [online] Available at: https://www.pbs.org/newshour/science/brains-reaction-time-peaks-age-24-study-finds#:~:text=The%20next%20time%20some%20twenty [Accessed 27 May. 2021].

Appendix

Age Group 1 and Age Group 2:

Unpaired *t* test results

P value and statistical significance:

The two-tailed P value is less than 0.0001

By conventional criteria, this difference is considered to be extremely statistically significant.

Confidence interval:

The mean of Age Group 1 minus Age Group 2 equals 69.1800

95% confidence interval of this difference: From 52.8265 to 85.5335

Intermediate values used in calculations:

t = 8.4218

df = 78

standard error of difference = 8.214

Learn more:

GraphPad's web site includes portions of the manual for GraphPad Prism that can help you learn statistics. First, review the meaning of P values and confidence intervals . Then learn how to interpret results from an unpaired or paired *t* test. These links include GraphPad's popular *analysis checklists* .

Review your data:

Group	Age Group 1	Age Group 2
Mean	331.7800	262.6000
SD	48.7600	17.9300
SEM	7.7096	2.8350
N	40	40

Age Group 2 and Age Group 3:

Unpaired *t* test results

P value and statistical significance:

The two-tailed P value equals 0.1397

By conventional criteria, this difference is considered to be not statistically significant.

Confidence interval:

The mean of Age Group 2 minus Age Group 3 equals -7.6500

95% confidence interval of this difference: From -17.8577 to 2.5577

Intermediate values used in calculations:

t = 1.4920

df = 78

standard error of difference = 5.127

Learn more:

GraphPad's web site includes portions of the manual for GraphPad Prism that can help you learn statistics. First, review the meaning of P values and confidence intervals . Then learn how to interpret results from an unpaired or paired *t* test. These links include GraphPad's popular *analysis checklists* .

Review your data:

Group	Age Group 2	Age Group 3
Mean	262.6000	270.2500
SD	17.9300	27.0200
SEM	2.8350	4.2722
N	40	40

Age Group 3 and Age Group 4:

Unpaired *t* test results

P value and statistical significance:

The two-tailed P value is less than 0.0001

By conventional criteria, this difference is considered to be extremely statistically significant.

Confidence interval:

The mean of Age Group 3 minus Age Group 4 equals -73.5800

95% confidence interval of this difference: From -101.5867 to -45.5733

Intermediate values used in calculations:

t = 5.2304

df = 78

standard error of difference = 14.068

Learn more:

GraphPad's web site includes portions of the manual for GraphPad Prism that can help you learn statistics. First, review the meaning of P values and confidence intervals . Then learn how to interpret results from an unpaired or paired *t* test. These links include GraphPad's popular *analysis checklists* .

Review your data:

Group	Age Group 3	Age Group 4
Mean	270.2500	343.8300
SD	27.0200	84.7700
SEM	4.2722	13.4033
N	40	40

Age Group 1 and Age Group 4:

Unpaired *t* test results

P value and statistical significance:

The two-tailed P value equals 0.4382

By conventional criteria, this difference is considered to be not statistically significant.

Confidence interval:

The mean of Age Group 1 minus Age Group 4 equals -12.0500

95% confidence interval of this difference: From -42.8334 to 18.7334

Intermediate values used in calculations:

t = 0.7793

df = 78

standard error of difference = 15.462

Learn more:

GraphPad's web site includes portions of the manual for GraphPad Prism that can help you learn statistics. First, review the meaning of P values and confidence intervals . Then learn how to interpret results from an unpaired or paired *t* test. These links include GraphPad's popular *analysis checklists* .

Review your data:

Group	Age Group 1	Age Group 4
Mean	331.7800	343.8300
SD	48.7600	84.7700
SEM	7.7096	13.4033
N	40	40

PARQ Form:

PAR-Q and YOU

(A Questionnaire for People Aged 10 to 76)

1.Are you feeling fresh and ready to participate in the experiment?

- Yes
- No

2.What is your age group?

- 10-11 years old
- 18-19 years old
- 44-45 years old
- 73-76 years old

3.Do you have epilepsy?

- No, I do not suffer from epilepsy and can participate in the experiment.
- Yes, I do have epilepsy and thus cannot participate in the experiment.

4.Do you understand the instructions that you received?

- Yes
- No

5.Do you consent to participating in this experiment and for the data collected to be utilised anonymously in a SEHS study?

- Yes
- No

6.Signature (write your name)

Submit

5. Do you consent to participating in this experiment and for the data collected to be utilised anonymously in a SEHS study?

100% of respondents (16 of 16) answered this question correctly.

More Details

Yes	16	✓
No	0