



SAMPLE B

Diploma Programme subject in which this extended essay is registered: Biology
(For an extended essay in the area of languages, state the language and whether it is group 1 or group 2.)

Title of the extended essay: Does the concentration of Amylase affect the eating speed and beverage intake of an individual while eating?

Candidate's declaration

If this declaration is not signed by the candidate the extended essay will not be assessed.

The extended essay I am submitting is my own work (apart from guidance allowed by the International Baccalaureate).

I have acknowledged each use of the words, graphics or ideas of another person, whether written, oral or visual.

I am aware that the word limit for all extended essays is 4000 words and that examiners are not required to read beyond this limit.

This is the final version of my extended essay.

Candidate's signature: _____ Date: March 5th, 2009

IB Cardiff use only: A: _____ B: _____

Supervisor's report

The supervisor must complete the report below and then give the final version of the extended essay, with this cover attached, to the Diploma Programme coordinator. The supervisor must sign this report; otherwise the extended essay will not be assessed and may be returned to the school.

Name of supervisor (CAPITAL letters) _____

Comments

Please comment, as appropriate, on the candidate's performance, the context in which the candidate undertook the research for the extended essay, any difficulties encountered and how these were overcome (see page 13 of the extended essay guide). The concluding interview (viva voce) may provide useful information. These comments can help the examiner award a level for criterion K (holistic judgment). Do not comment on any adverse personal circumstances that may have affected the candidate. If the amount of time spent with the candidate was zero, you must explain this, in particular how it was then possible to authenticate the essay as the candidate's own work. You may attach an additional sheet if there is insufficient space here.

Little time was spent discussing the procedure for this extended essay despite my encouragement. When I received the final copy of the essay it was not what I had originally discussed with the candidate. I feel that he left it to the last minute and when faced with a deadline quickly threw something together.

He did not do any of the formatting changes I suggested or change the biological focus of the topic. Formatting changes included placing titles on all data tables and graphics and not writing in the first person or cracking jokes. All in all, it was not a well done essay. ✓

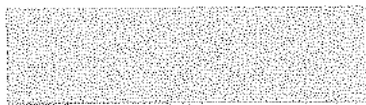
I have read the final version of the extended essay that will be submitted to the examiner.

To the best of my knowledge, the extended essay is the authentic work of the candidate.

I spent 1-2 hours with the candidate discussing the progress of the extended essay.

Supervisor's signature: _____

Date: March 5, 2009



Candidate Name:
Candidate Number:

Does the concentration of Amylase affect the eating speed and beverage intake of an individual while eating?

Extended Essay



Source: (<http://www.gnurf.net/v3/clip-art/free-clip-art-eating-pizza-027.html>) (Accessed 25th Feb, 2009)

Subject: Biology HL

Supervisor:

Candidate Name:

School:

Candidate Number:

School Number:

Exam Session: May 2009

Word Count: 3659

Abstract: 283

✓
Holistically = 1 at least based on the teacher and

Abstract

In this experiment I will be looking at an unsolved question of: "Does the concentration of amylase affect the eating speed and beverage intake of an individual while eating?" My hypothesis is that amylase will affect it. The eating speed is defined as how long the individual takes to eat one slice of pizza. The concentration of amylase pertains to the general amount of amylase in that individual's saliva. Beverage intake on the other hand, is defined as the amount of beverage drank while eating the slice of pizza because of thirst. I will be explaining further in this paper the general concentration of amylase and the beverage intake. I have produced a procedure in which I can test this. A summary of the procedure is picking out testers to eat a slice of pizza, and while they are eating I will be timing how long it takes them to finish a slice of pizza. As soon as they have finished I will take their beverage, Crush Orange pop in this case, and measure the remaining with a graduated cylinder. In the lab I will be using Benedict's reagent, some starch soluble, and my tester's saliva to get a color which will tell us how much amylase was in the saliva. Then I will be comparing each tester's saliva solution color to determine who has a higher amylase concentration. In the end, the result came out to be similar to my expectation, the amylase did have an effect on the eating speed and the beverage intake of an individual, but the way it affected it was different. Thus I concluded that amylase alone had no effect on the eating speed and beverage intake.

Not clear exactly how you collect in your
data.

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Done + accurate

Introduction

During our lifetime we eat many things: bitter, sour, salty, sweet, or a combination of these. We sometimes eat these alone, sometimes with our families, friends, strangers, and bosses or with others. While eating with other people, we sometimes notice things such as eating habits, preferences, or eating speed. Most individuals generally notice other people's eating speed in relation to theirs. For example: let's say Mark and Eric are sitting at a table eating. They would both be busy eating their own food at first. Sooner or later, Eric finishes his food, and looks at Mark and notices that Mark eats slower than him. This would be a typical case when eating with another person and happens more than often in the school's cafeteria. Everyone would be eating, and someone finishes their food first, and waits for everyone else. It becomes clear that this person eats really fast.

Situations similar to this have happened to me. In school, we would be eating, and all of a sudden everyone around me has finished their food. I'm one of the slower eaters. The faster eating people would point out that I'm eating slow by saying something like, "Peter, you eat so slow". I've heard this many times. Although it does bother me sometimes, but I like to enjoy my food and savour the taste of it rather than just shoving it down my throat.

That's where my topic comes from: Does the concentration of Amylase affect the eating speed and beverage intake of an individual while eating? Amylase is an enzyme that exists in our saliva. It breaks down starch (polysaccharides) into simpler sugars (disaccharides and eventually into monosaccharides). When an individual ingests food and chews it, they are adding and mixing amylase into the food they've ingested. This will allow the amylase to react with the starch in the food and convert the starch. This would allow the individual to emulsify the larger starch into smaller pieces of monosaccharides, which would be easier to swallow. *where?*

Amylase concentration ^{in saliva} is determined by genetics (Hjorth). Although it is determined by genetics, it fluctuates over time (Hjorth). If you eat starch ^{rich?} heavy food, then your body will automatically start making more amylase to digest that starch. Since amylase is also made in the pancreas (SydPath), the amylase concentration does not change too much in saliva. In saliva, the increase is very minute, while the increase in the pancreas is high compared to the changes in the *mechanism?*

saliva. This is because amylase from the saliva is only used up until the amylase gets denatured in the stomach. After the chyme enters the small intestine, the pancreas injects pancreatic fluid. This would eventually make all starch into monosaccharides and doing this would make the starch small enough that the cells are able to absorb it.

As I have said before, amylase concentration is determined by genetics. For salivary amylase the genes AMY1A, AMY1B and AMY1C determines the output. There can be more than 1 copies of this gene. Depending on the amount of the copy, it determines the amount of amylase you produce. It is thought that this gene is copied again and again because of past ancestral diets (Perry).

The saliva secretion rate is a whole different matter. It fluctuates greatly at different times. When you've worked the whole day and go home to see your parents preparing a delicious meal for you, you start to salivate. Certain smells can also increase salivation, but this usually happens when you're hungry.

I think that since the digestion happens quicker if you have more amylase, which would mean it would increase your eating speed, and this would also increase your beverage intake while eating. The beverage intake I am talking about here is the thirst created by the food being eaten. This thirst is usually created by a lack of water in saliva which I will explain soon. Going back to my hypothesis, I think that if you have more amylase your eating speed would increase because the amylase emulsifies the starch making it into small pieces, and this allows you to swallow your food more easily. A good analogy would be eating Rockets (round pieces of candy) or eating powdered Rockets (same candy, except crushed). You would have to chew the normal Rockets to make them smaller and then swallow, whereas the powdered Rockets will simply mix with your saliva and you can just swallow your saliva. From here, I can explain the reason why having more amylase would need to increase the beverage intake, and heighten your thirst. Saliva is about 99.5% water (McCloud). This would mean that about 0.5% is things other than water. Amylase is one of those. This means that if the concentration of amylase is increased, then there will be less water. Having less water would lead to less water mixing with the food. There will be less water to lubricate the food to make it go down your oesophagus. In the first steps of digestion which is making a bolus, the mouth chews and grinds food until it is broken enough to make a ball. Then it is moistened with water (saliva) so that it will lubricate the bolus and help

Some attempts to put the Rd. into context
Lack of / very simplistic / little use of Biological
Terminology

the bolus go down the oesophagus (Turner). So, you would need to increase your beverage intake while you eat to make up for that lack of water in your saliva. Therefore I think that having more amylase would increase the speed of eating and increase the beverage intake while eating. This should also work vice versa if my hypothesis holds true.

You make a number of
unsupported assumptions
There are many
variables
have not con

Apparatus and Material

The apparatus and materials you will need for testing this question are as follows:

- 1) 'X' number of testers
- 2) 'X' number of pizza
- 3) 'X' number of Crush Orange pop
- 4) A stopwatch
- 5) Benedict's solution
- 6) 3 Beakers (250mL)
- 7) Two droppers
- 8) 'X' number of Test tubes
- 9) Test tube rack
- 10) Iodine solution
- 11) Starch soluble
- 12) A hot plate
- 13) Water or distilled water. (will make no difference)
- 14) Graduated cylinder

Procedure for Data Collection and Possible variables Affecting the Procedure

The method of collecting the data for this experiment is to get some human test subjects. I have chosen 9. I thought that 9 would be fine, because it's a number that would give me a good average if I picked the people randomly from a small population such as the people in IB in grade 12 at our school (roughly 20 people). To lessen the factors that would affect this experiment I've chosen people who are around the same age and males (I am not being sexist, but I do have a deadline). Once the subjects have been chosen, chose a food they will eat. The

Simplest approach - multi-step planning?

food will have to be roughly the same size. I've chosen slices of pizza. All of the ones my testers ate were roughly the same size. As for the beverage, I've chosen a 355mL bottle of Crush orange pop because of my tester's preferences; otherwise, any soft drink would have been fine.

Once you've chosen the food and testers, all you have to do is to give them a slice of pizza and pop and let them eat it, but remind them to eat it normally, otherwise they'll mess up the data by trying to eat it fast. While they eat, you'll need to time them from their first bite until they've shown you their mouths that they've swallowed their food. Then measure and record how much pop they've drank. This will indicate their eating speed and their beverage intake while eating.

Once you've acquired the eating speed and beverage intake, you'll have to get their saliva. Before you get their saliva, it would be for the best to wash their mouths, so that "other things" will not hinder our data. It would be even better if you did this part of the lab before the eating part. Also make sure that they have had nothing to eat or drink for two hours prior to the collection of saliva. Getting about 2~5mL of saliva should ensure a good result. Now, to the lab.

For the lab, you will need a hot plate for heating the saliva solution, some beakers and test tubes, Benedict's reagent, and starch soluble. First of all, you will need to gather the materials and apparatuses of the lab. Set up a hot water bath with the hot plate and a beaker and let it boil. While the water is heating up, mix the starch soluble with water to make a starch solution so that it will be easier to mix with the saliva. Then mix 2ml of saliva with 2mL of the starch solution in a test tube. Mix well, and hold it in your hand or keep it warm for about one minute so that the amylase will react faster with the starch. Then add about 3mL of Benedict's reagent and mix well. The color should be clear blue, and the solution may be a little bit transparent at the top. When the water is boiling, put your solution in and leave it for 5 minutes and no more otherwise you will get a false positive result. As you wait, there should be a color change. After 5 minutes are over, mix the solution a bit. Then note the final color, or take a picture. Repeat this process until you have completed this with all of your tester's saliva.

Depending on the color it changes to, the solution will tell us how much amylase is present. If the Benedict's reagent remains a clear blue and there is no precipitate, it suggests that the starch has not been converted to sugar, so there is very little or no amylase. If the color changes to a red, then there are high amounts of sugar present. This would also signify that there are lots of

*info
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cal*

amylase in the test saliva and are working on breaking down the starch. Here is a color chart to explain the effects of Benedict's reagent on glucose:

Table 1






	0	*Blue	None
	+	Green	Some
	++	Yellow	More
	+++	Orange	Much
	++++	Red	Most
Color	Symbol	Description	Amount of Amylase Activity
	* blue = 0 (no precipitate; no color change)		

Table taken from <http://samson.kean.edu/~breid/enzyme/enzyme.html>, the lab procedure is also taken from there.

Although the concentration of amylase cannot be determined numerically, we can roughly judge by the difference by color. This color change happens because of the interactions of the Benedict's reagent with glucose. Certain sugars are called reducing sugars because of their ability to reduce and act as a reducing agent. Here are some examples of reducing sugars: Glucose, Fructose, Lactose, and Maltose (Wikipedia). Since Glucose is a reducing agent, it is able to reduce the copper in the Benedict's reagent, which is represented by the "plus" signs in our table. The more "plus" signs means that more copper are getting reduced and that there are more glucose in our solution, this forms a precipitate containing copper. This precipitate is what makes our solution redder and redder as there are more glucose, and by extension, as there is more amylase, because amylase is what is converting starch into glucose. *maltose*

This procedure works for the data collection for my extended essay topic because I need a general measure of amylase concentration in human saliva along with time required to eat something (pizza) and the amount of beverage drank while eating. With these values I am hoping to find a general pattern where higher concentration of amylase would yield faster eating times along with more beverage intake. The general amylase concentration would mean, in this paper, that we have a grasp of who has more amylase and who has less. We do not need a completely

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accurate measure. We only need to know something like this: A has more amylase than B, A eats faster than B, A drinks more pop than B. We can conclude from here that since A has more amylase, it increases his eating and increases drinking whereas B has less amylase so he eats slower and drinks less. This table helps us with this. It basically says that the redder the solution the more amylase you have than a guy with a bluer solution.

The control of this experiment would be a solution containing only the Benedict's reagent, starch and water. The solution is a clear blue before and after being heated. It is a bit like the solution before heated that's presented in the Data Acquired portion, but it is clear blue with no white at the top and there are bits of un-dissolved starch at the bottom.

Also for the sake of simplicity I will be using letters as the names of the individuals I have used for this experiment.

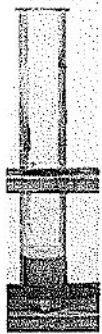
argument here is not convincing.

Data Acquired and Processing

✓

An example of the solution containing Benedict's reagent, saliva, and glucose before heated:

Figure 1



This is what the solution should look like before heating and a color change. This is the solution containing the saliva of tester A before heating. It should serve as a guide should you want to test it.

are there really necessary?

The results when the solutions are heated and mixed:

Figure 2



Tester A

Figure 3



Tester B

Figure 4



Tester C

Figure 5



Tester D

Figure 6



Tester E

Figure 7



Tester F

Figure 8



Tester G

Figure 9












Tester H

Figure 10



Tester I

Table 2

Tester Letter	Time (minutes : seconds)	Beverage drank	Final color of solution	Description of final color
A	7:29	131mL		Orange green
B	7:18	79mL		Kiwi green
C	18:43	274mL		Orange
D	11:06	288mL		Dark orange
E	14:25	336mL		Orange
F	17:53	268mL		Dark Orange
G	12:59	355mL		Light orange
H	8:35	253mL		Dark Orange
I	5:55	152mL		Dark Orange

In this table of data we are able to compare the final color of each person's solution. The way to interpret this table is that the time would indicate how fast a person will eat a slice of pizza. Then there is how much pop they had to drink because of the thirst created by eating pizza. Then there is the color of the solution. The color of solution can be read that the redder or browner the

control - 6 acids saliva?
- starch solution?

color becomes, there is more amylase. As I have explained above in procedure, along with table 1, that the glucose reduces the copper in the Benedict's reagent, which makes the isolates the copper, and thus exposing the copper and making the solution red.

By using table 1, which I have included in the procedure, I will highlight some of the 'extreme' cases of amylase presence of lack thereof. In my data, tester A would have very low amylase contents in their saliva. This is proved because we did a test and their color came out to be a mix between an orange and a green but more so and the green side. In table one this would be close to a **yellow**. We can see that not many copper has been reduced by glucose. This is because there wasn't enough glucose to make this solution any redder than it is now. In this case, tester A has 'more' amount of amylase activity, and this is because tester A has 'more' amylase.

Tester B has even less amylase than tester A. Tester B has a Kiwi green color. Looking at table 1, we can say that his color is closest to being **Green**. Here, very little copper in the Benedict's reagent has been reduced, that is why it is green. The amount of amylase this person had was not enough to produce any more glucose to reduce any more copper. This would mean that tester B has 'some' amount of amylase activity, because he has 'some' amylase.

Tester G has moderate amounts of amylase. He has a light orange color. Looking at table 1, we can say that his color was closest to **Orange**. His amylase converted enough starch into glucose that the amount of glucose converted was able to interact with the copper in the Benedict's reagent to make an orange color. Tester G has 'much' amylase activity, which leads to having 'much' amylase.

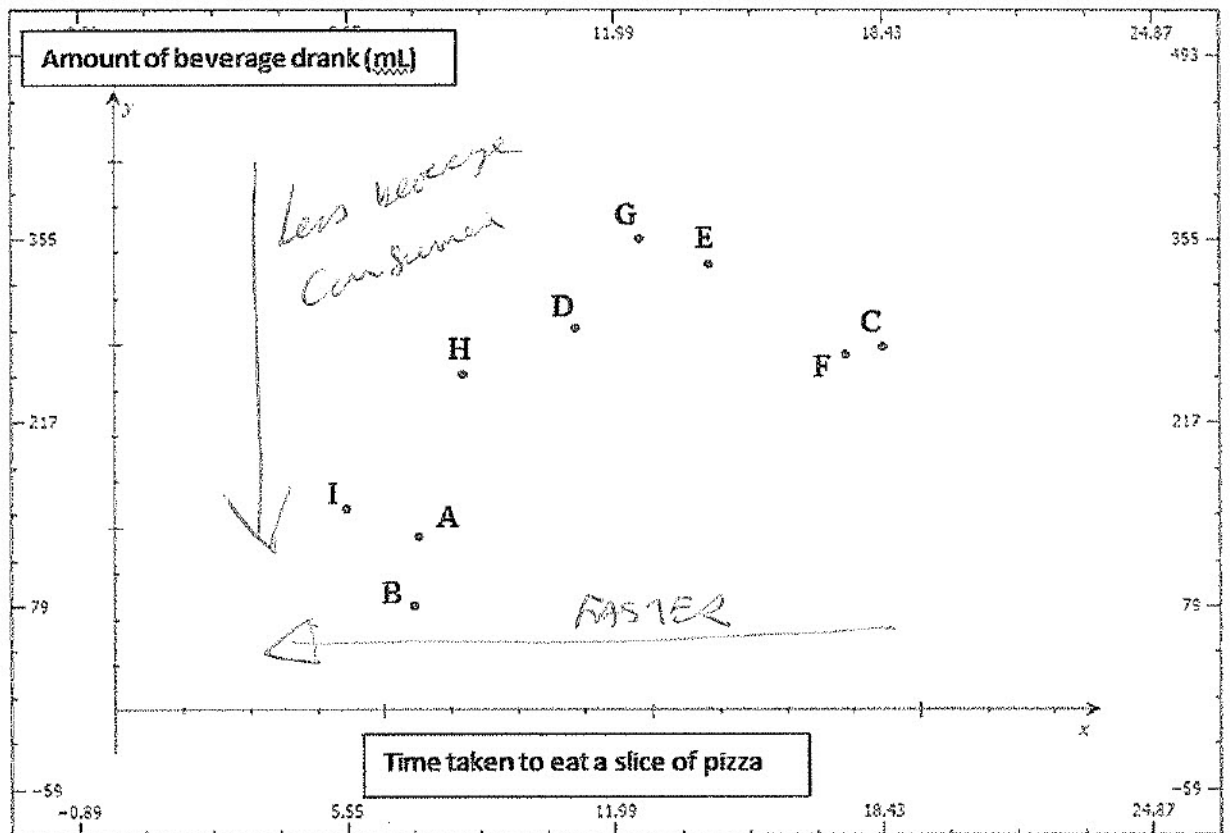
Finally, Tester I. This person had the reddest solution of all. This person had dark orange, and was very close to red. This person's color was closest to a **Red** in table 1. That would mean that his amylase has converted a lot of the starch into glucose allowing those glucose to interact with the copper in Benedict's reagent. Tester I has 'most' amylase activity, which leads to having 'most' amylase.

As you can see, most of the tester's amylase falls either in orange or red other than tester A and B which I have mentioned above. If you use the method I used for the 4 people above for classifying, the order from least amount of amylase to most amount of amylase is: B, A, D, G, E, C, F, I, and H.

So... ?
... ?

With this data we are able to set up a time vs. beverage drank graph. The x axis representing time and the y axis representing the amount of beverage drank:

Graph 1 (Drawn with Microsoft Math)



In this graph, we can see that there is a definite correlation between eating speed and beverage drank. As eating speed goes up, so does drinking amount. The letters represent the testers. We've established the order of the testers by increasing amylase content in their saliva. In this graph, the order is: I, B, A, H, D, G, E, F and C. If we compare this with our 'tester amylase order' we can see that D, A, D, G, E and C went up as amylase content went up. I, H and F however were random and did not follow a pattern. We can say that these are random errors. Therefore, we conclude that, as the concentration of amylase goes up, the eating speed goes up, and so does the amount of beverage drank.

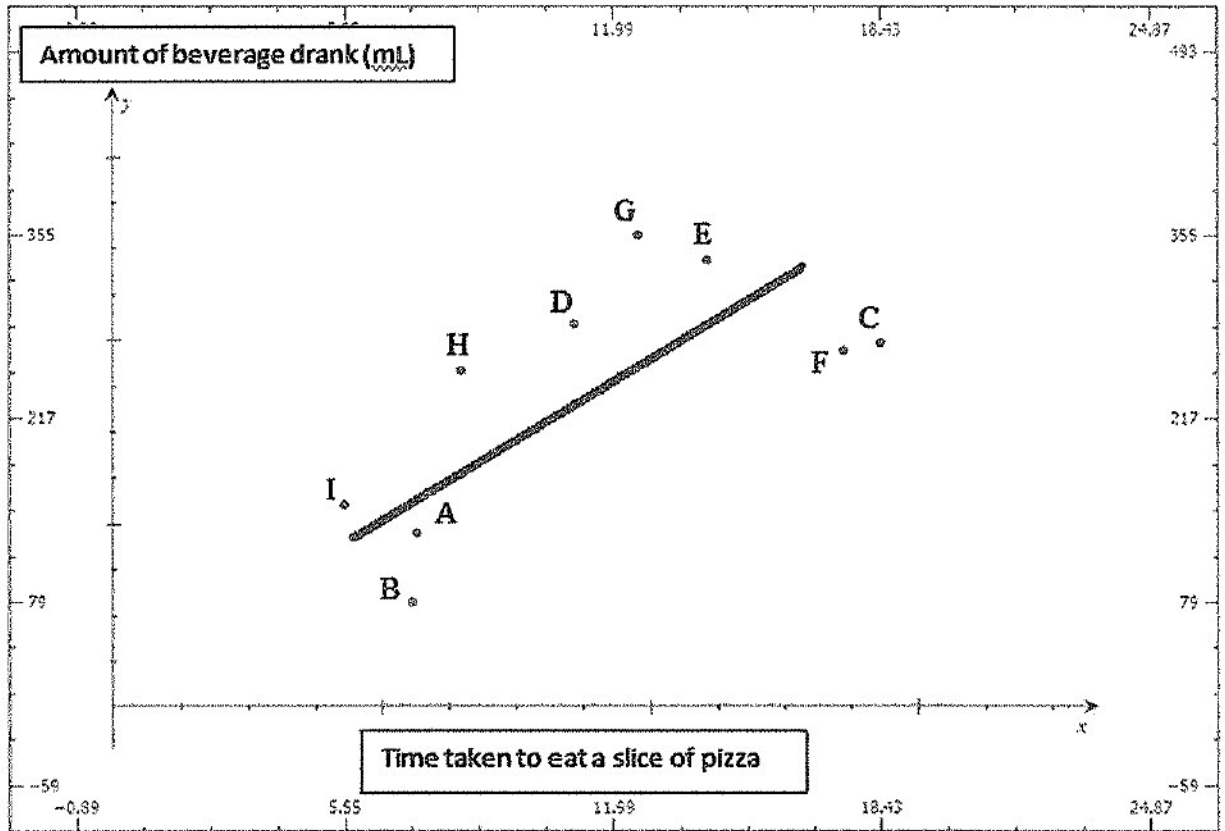
Of course this is not true in every case, but I am speaking in a general manner. If we put a best fit line, the line would have a positive slope. It would generally look like this:

the opposite is in fact true based on your data. I, A + B have the fastest times (shortest!) and

*W
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dal
son*

Graph 2



The red line is the Best Fit line

We can see here that there is a general positive relation between these two variables. The slope of the red line is obviously positive although it is difficult to determine the equation or the actual slope of the function. *software will do this.* The important thing is that the slope is positive and that there is a positive relation between these two variables.

Analysis and Evaluation

Salivary amylase, called ptyalin, is constantly being produced by the salivary glands. It is an essential enzyme where it hydrolyzes starch into smaller sugar compounds such as maltose or glucose. Amylase is an enzyme that exists in almost every mammal (Encyclopædia Britannica). It is THE enzyme used for the breakdown of starch.

Amylase is one of the most important enzymes in the human body. Without it we would not be able to break down starch, into small monosaccharides. Since most large starch is insoluble, we

An fact - as eating speed "went up", volume of beverage consumed "went down"

would not be able to transport it throughout our body. We need sugar in our brains for it to function properly. It is tested that sugar is needed in our brains when we use certain parts of the brain (The Franklin Institute). We need a constant supply of amylase in order to breakdown the starch that is consumed; otherwise there will be a build up of non soluble starch and will just pass through the digestive system rather than being absorbed by the cells to be reallocated to the brain or other parts of the body. *In what sense is this an "evolution"?*

If we take a look at the data we can see that there is a general trend, as I have mentioned before, of the amount of beverage drank being dependant on the time it takes to eat. So, as a person takes longer to eat, they tend to drink more pop. *The longer you sit at a table the more you will probably drink*

As I have explained that the trend of the amylase content has a direct relationship. Since we treated I, H, and F anomalies, we are left with B to C. They had a distinct relationship with both of the variables mentioned. This meant that as amylase concentration went up, the eating speed went up as well as the beverage drank. This would suggest that as amylase concentration goes up, everything else goes up as well. Because of this, my hypothesis is ineffective.

A possible explanation for this is that amylase actually slows down the eating speed. This could be because lower amylase concentration in saliva gives yield to a higher water concentration. This water would mix with the food and would make it easier for the mouth to make a bolus (TurnerDelia). This would make it easier to swallow your food, which would add to your eating speed. If you have more amylase it means less water. You would lack water to mix with the food to make a bolus. This would make you drink water (pop on our case) so that the water would mix in with the food to help make a bolus, thus making up for that lack of water. *What about H₂O and Th₂*

Conclusion

With the data collected and a rejected hypothesis, I set out to do another lab such as this with a new hypothesis. In the end, my data did not match my hypothesis. It came clear to me that the amylase itself had nothing to do with the eating speed, because salivary amylase does not impact a whole lot short term wise. As soon as we swallow food, salivary amylase can have no effect on our eating speed no matter what. Because one bite of food remains in our mouths for 2 minutes tops, amylase does not have enough time to work on the food. That is why amylase has no direct

*Repetition
Concise
Comparison*

*His speed have been
close from the
experiment.*

effect on eating speed. But, it can affect the eating speed by simply existing or not. As I have explained in my hypothesis and my analysis, more amylase means less water and vice versa. Water is the thing that directly affects your eating speed. This is because water lubricates the food and makes it into a bolus which makes it easier to go down the oesophagus (TurnerDelia). This is still only in its hypothesis stages; therefore there will be more testing in the future about this.

*Conclusion not fully supported by
the investigation.*

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Some suitable resources but not
well used!



Assessment form (for examiner use only)

Candidate session number	
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Too good

Many uncontrolled variables not taken into account.

The structure of the essay was OK, but the basis of the investigation were weak.

Assessment criteria

A research question

B introduction

C investigation

D knowledge and understanding

E reasoned argument

F analysis and evaluation

G use of subject language

H conclusion

I formal presentation

J abstract

K holistic judgment

Achievement level

First examiner maximum Second examiner

 2

 2

 4

 4

 4

 4

 4

 2

 4

 2

 4 ✓

Total out of 36

✓

✓

Name of first examiner: _____
(CAPITAL letters)

Examiner number: _____

Name of second examiner: _____
(CAPITAL letters)

Examiner number: _____