

Addressing the Underlying Cardiovascular Hemodynamic Physiology of Upper-Body Stretching in Healthy Adults

Applied Science Project

Arvind Raj

Dr. Robert S. Sheldon, Rashmin Hira, Priyanshu Giri

Calendars

September

<i>Sunday</i>	<i>Monday</i>	<i>Tuesday</i>	<i>Wednesday</i>	<i>Thursday</i>	<i>Friday</i>	<i>Saturday</i>
	1	2	3	4	5 Create Calendar, Daily Notes, and Title Page Template for Logbook	6
7	8	9 Meeting with Mrs. Kale, regarding ASP progress Further work on Calendar & Daily Notes – begin recording notes from summer research	10	11 PaperPile installation (majority of classtime) Gather 5 papers to read & analyze for Research Proposal, and to input into PaperPile	12	13
14 Create update-reco rding template for Dr. Sheldon – contains information such as #AFTs done, files analyzed + cleaned, etc.	15 Meeting with Dr. Sheldon Work on given tasks (update-record ing template alterations, systematic-rev iew-informatio n-consolidatio n) (AFT Day)	16	17 Finish Daily notes for summer research, and work on Daily Notes for September so far Further work on update-record ing template and systematic-rev iew informatio n	18 Send Rashmin update-record ing template	19 Meeting with Mrs. Kale, regarding ASP progress Complete Systematic Review Information Document, and send to Rashmin	20 Research for Research Proposal (Read the already-coll ected papers, and more)

21	22	23 Begin draft of Research Proposal, following rubric-criteria – Work on Background Research, primarily	24	25 Meeting with Dr. Sheldon (½ class, approximately) Further work on Research Proposal, as much as possible, accounting for meeting	26	27 Dr. Sheldon Goes on call – communication impeded
28	29 (AFT Day) Meeting With Mrs. Kale regarding progress so far Work on Research Proposal Send out calendar invitations for future meetings with Dr. Sheldon today	30 Rough Draft for Research Proposal Due ASP Logbook Check				

October

<u>Sunday</u>	<u>Monday</u>	<u>Tuesday</u>	<u>Wednesday</u>	<u>Thursday</u>	<u>Friday</u>	<u>Saturday</u>
			1 Regain Outlook access Determine if additional support is required for ASP – search for some, if necessary	2 (AFT Day)	3 Aim to organize meetings for the next 2 months with Dr. Sheldon Aim to set up a meeting with Priyanshu to gain additional assistance on the project	4
5	6	7 Meeting With Mrs. Kale Sort out additional patient recruitment for Stretch-Induced Syncope Project, outside of AFTs. Inquire to Rashmin about this.	8 Meeting with Priyanshu for help with Systematic Review Screening, Stretch-Induced Syncope assistance, and general help on the project	9 Have milestones for Stretch-Induced Syncope project and Systematic Review done by today	10 Meeting With Dr. Sheldon Have REDCap fields emailed to Priyanshu by today Set up a Covidence account by today	11 Import papers into Covidence for Systematic Review Complete ½ of background research
12 Begin Screening papers for Systematic Review Complete other ½ of background research	13 Begin writing research proposal, background on stretch syncope, what is syncope, history / basic, broad definitions of the disorder	14 (AFT Day) Aim to begin analyzing data for cleaned files for Stretch-Induced Syncope project	15	16 Meeting with Mrs. Kale Aim to finish Research Proposal Introduction Section by today Ask Rashmin for Specific Methodology	17	18

				Information for Stretch-Induced Syncope Project & Research Proposal		
19 Rashmin goes out of town - back on the 27th Aim to have finished screening process for Systematic Review	20 Ask Dr. Garcia for an extension on research proposal + oral presentation	21	22 (AFT Day) Absent Due to Illness	23	24 Meeting With Mrs. Kale Complete Significance and Objectives Sections for Research Proposal	25
26	27 Rashmin back in town Meeting With Dr. Sheldon	28 (AFT Day) Aim to implement edits from Dr. Garcia on Research Proposal If given additional time, finish as much of Methods as possible (it has been stalled long enough)	29	30 October Logbook Due Listen to Research Proposal presentations from classmates Ended up having terrible headaches, and stayed home ill	31	

November

<u>Sunday</u>	<u>Monday</u>	<u>Tuesday</u>	<u>Wednesday</u>	<u>Thursday</u>	<u>Friday</u>	<u>Saturday</u>
						1 Complete Research Questions, Methods for Research Proposal
2 Finish Variables section, Hypothesis section, fix citations, and send Research Proposal off to Priyanshu for editing (he said that he's fine to do so on short notice)	3 Meeting with Dr. Sheldon Final, fully-edited copy of Research Proposal due	4 Create Oral Presentation slideshow (based on Research Proposal information), in full	5 Have speaking notes for Oral Presentation complete – be ready to present it to a relative	6 Getting bottom row of wisdom teeth removed today – likely going to miss next ASP class (supposed to be my Oral Presentation day)	7 Listen to Oral Presentations from Ronald, Shicheng, and Anika <i>Missed this ASP class after having bottom row of wisdom teeth removed (day prior)</i>	8
9	10 (AFT Day)	11 Do 2 trial runs for Oral Presentation, and have speaking time within about 1 minute of the maximum (12 minutes)	12 Do 2 more trial runs for Oral Presentation, and feel confident going into presentation-d ay (having timing within 12 minutes)	13 Oral Presentation, based on Research Proposal, today	14 (AFT Day)	15
16	17 <i>Absent from ASP class today – had knee problems, and didn't come to school, resting</i>	18	19 Meeting with Mrs. Kale Aim to update Rashmin and Priyanshu on the state of the SIS and	20 Fix November ASP Calendar for Logbook – it is currently out of date (Just as a	21 Send a Weekly Update to Dr. Sheldon, Rashmin, and Priyanshu Consolidate	22

			Systematic Review projects	note, it is now updated)	notes taken from ASP class into specific Logbook entries for the month	
23	24 Meeting with Dr. Sheldon	25 <i>ASP class cancelled today due to President's Breakfast speech and event</i>	26	27 Final copy of November Logbook due today	28	29
30	Although it was not mentioned in the specifics of my calendar entries, November was a very difficult month for me, characterized by health concerns, appointments, and an enormous school-workload (and test-load). As a direct result, very little progress on my SIS project or Systematic Review was made; I hope to rectify this during the month of December and over Winter Break.					

December

<u>Sunday</u>	<u>Monday</u>	<u>Tuesday</u>	<u>Wednesday</u>	<u>Thursday</u>	<u>Friday</u>	<u>Saturday</u>
	1 ASP class cancelled due to President's Breakfast presentation (AFT Day)	2	3 Meeting with Mrs. Kale Have CYSF form completed by today (Basic Project Information & Ethics and Due Care 2A Forms)	4 Have all 10 files analyzed by today, and report findings (signal, no signal, consistency), and presence of standing stretch signals	5 Meeting With Priyanshu and Rashmin	6
7 Create a Powerpoint slideshow containing all of the stretch images for Dr. Sheldon to examine	8 Meeting With Dr. Sheldon Present stretch signal findings to Dr. Sheldon today	9 (AFT Day) Meeting With Mrs. Kale	10	11 Today can be used as a day-off in order to catch up with other pending homework, due to significant progress	12	13 Email Martin about the code-creation (for stretch-data extraction)
14	15 (AFT Day) Meeting With Dr. Sheldon Meeting With Mrs. Kale Meeting With Rasha	16	17 Update and complete Introduction Section, based on Research Proposal Introduction (Same Exact Material)	18 Meeting With Govind	19 Introduction Section final copy due Last day of school before Winter Break	20 First day of allotted 2-week long winter break; regular schooling will resume on January 5, 2026
21	22 Fix stretch markers & clean stretch data files (as many as possible, but at least one)	23	24 Clean all of the remaining stretch data files (if any)	25	26	27

28	29 Create new code specifications / parameters for Martin and his new code development	30	31	
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January

<i>Sunday</i>	<i>Monday</i>	<i>Tuesday</i>	<i>Wednesday</i>	<i>Thursday</i>	<i>Friday</i>	<i>Saturday</i>
				1	2 Test Martin's New Code, and Ensure That It Fits My Described Parameters	3
4 Last Day of Winter Break – School Begins Again Tomorrow, Rapidly Followed by Midterm Exams	5	6 Begin work on CYSF Significant Risk 2B Form; If Unable to Finish, Will Have to do so After Midterms	7	8 Prepared / Wrote my High School Big Data Challenge Manuscript, With the Permission of Dr. Garcia & Mrs. Kale	9 First Midterm Exam Today (Physics)	10
11 Re-Send Calendar Invitations for Meetings in the New Year	12 (MIDTERM EXAM BREAK)	13 (MIDTERM EXAM BREAK)	14 (MIDTERM EXAM BREAK)	15 (MIDTERM EXAM BREAK)	16 (MIDTERM EXAM BREAK)	17
18 Obtain Informed Consent Information Send a General, Winter Break Progress Update to Everyone	19 Final Midterm Exam (Human Geography)	20 Meeting With Mrs. Kale Submit Significant Risk 2B Form By the End of the Day Today	21	22 Meeting With Dr. Sheldon (This Meeting was Missed Due to Illness, and Dr. Sheldon was Informed)	23	24

25	26 Ask for an Extension on Methodology Paper (From February 19th Until After the CYSF Portal Closes [March 4th])	27	28 Feeling Unwell Today, So Plan: Try to Get Well	29	30 Clean Stretch Files From December and January that Priyanshu Sends Me After School Today	31 Meet With Priyanshu at the Public Library to go Over Necessary Statistical Tests & SPSS Practice
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February

<i>Sunday</i>	<i>Monday</i>	<i>Tuesday</i>	<i>Wednesday</i>	<i>Thursday</i>	<i>Friday</i>	<i>Saturday</i>
1 Run Descriptive Demographics, Descriptive Statistics, and One-Sample T-Tests in SPSS	2 Run Paired T-Tests in SPSS	3 Re-Run Descriptive Demographics With Updated Demographic Data	4 Meeting With Dr. Sheldon Begin Working on Libin Research Day Abstract	5	6 Libin Research Day Deadline (Original Deadline, Before Extension)	7
8	9 Meeting With Mrs. Kale Begin Adding Data to Abstract, If Necessary Time is Available	10	11 Absent Today Due to Illness; Plan For This Class Block is to Rest and Try to Get Better	12	13 Meeting With Dr. Sheldon	14
15 Libin Research Day Abstract New Submission Deadline	16 Have Figures, Using GraphPad Prism, Fully Created By Today	17 Used ASP Block Today Preparing for Western Canada HSBDC Symposium on Friday	18	19 Meeting With Dr. Sheldon Used ASP Block Today Preparing for Western Canada HSBDC Symposium on Friday	20	21
22 Have Presentation for Oral Presentation Created and Rehearsed By Today (Can Either Use Poster or Google	23 Pre-Science-Fair (PSF) Oral Presentation For Me Day 1 of PSF Oral Presentations	24	25 Day 2 of PSF Oral Presentations (I was absent due to illness)	26	27 Day 3 (Final Day) of PSF Oral Presentations Create Poster in Down Time Today	28 Print Poster Reach for the Top Regional Tournament Today

Slideshow)



March

<i>Sunday</i>	<i>Monday</i>	<i>Tuesday</i>	<i>Wednesday</i>	<i>Thursday</i>	<i>Friday</i>	<i>Saturday</i>
1 Complete CYSF Problem, Research, and Method Sections, Along With Citations (Keeping Even Those References That Were Unused in Final Research)	2 Webber School Science Fair (Qualifiers for CYSF, Top 15 Selected) Complete CYSF Written Sections (Data and Conclusion)	3 Record CYSF Oral Presentation (10-Minute Presentation) for the CYSF Portal, and Submit Logbook to CYSF Portal CYSF Portal Fields Need to be Complete in Order to be Selected to Attend the CYSF	4 Begin Working on Data Extraction for Systematic Review (1 Paper)	5	6 Continue Working on Data Extraction for Systematic Review (2 Papers)	7
8	9 Methodology Section Due	10	11 2 More Papers for Systematic Review Data Extraction Done	12	13 Complete Systematic Review Data Extraction (2 Papers)	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Daily Notes

Broad Summer Notes

Notes:

- First went into the University of Calgary on July 7, 2025
 - Last day was on August 22, 2025
 - Went in every weekday, barring holidays and Friday August 1, 2025, when I was excused in order to go on a trip to Detroit for a major family event
- By July 9, 2025, I had finished all of the training courses that I had been requested to complete, including University of Calgary-specific courses, TCPS-2, and CITI courses
 - [Arvind Raj - Certificates for Course Completions - U of C, TCPS-2, & CITI](#)
- During July, broadly, I did the following:
 - Obtained my UCID and physical UniCard
 - Read the following Standard Operating Procedure for Autonomic Function Tests (AFTs)
 - [AFT Master SOP 2024May03_AP](#)
 - I would later be using AFTs as the primary method to gaining Stretch-Hemodynamics-Data for my ASP project
 - Helped to perform multiple AFT tests, gaining invaluable experience and knowledge regarding my ASP methodology
 - On July 17, 2025, the first AFT with an included Stretch-portion was performed; I was present, and was there to ensure it ran smoothly
 - Created the following documents:
 - An information document for a brief, free course I took on Systematic Reviews: [Systematic Review Information](#)
 - A document outlining my ideas for future Stretch-testing, that Dr. Sheldon and I discussed, ultimately agreeing that we would not adopt the practices for testing, but keep them in mind for potential future use:
 - [Stretch Syncope Thoughts](#)
 - Learned the basics of MATLAB, a coding software, and MiniP, a script that allows for the manipulation and viewing of LabChart files – AFTs come in the form of LabChart files
- During August, broadly, I did the following:
 - Completed a Johns-Hopkins course regarding Systematic Reviews, and how to properly perform them
 - Signed up for Libin Summer Student Research Day
 - An event where Summer Students are able to present on the research that they have been performing throughout the summer
 - I created both an abstract for my submission for Summer Student Research Day, and a poster, the latter of which I personally presented

- Abstract:
 - [W SISMMethods_SummerResearchDayAbstract 20250804 AR.FIN...](#)
- Poster:
 - [P AR SISMMethods_SummerStudentResearchDayPoster 20250818...](#)
- Presented my poster on August 22, 2025, my last day at the lab, for the summer

08/29/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Status-Check for ASP Teachers <ul style="list-style-type: none"> ○ DUE NEXT CLASS (Next Wednesday) ○ Met with mentor? ○ Where are you at? Topic? ○ Literature been read? ○ Meeting times established? Weekly, biweekly, otherwise? ○ Mention Poster, Research, 7 AFTs, Systematic Review ● Figure out what logbook-style I want to use <ul style="list-style-type: none"> ○ DUE NEXT CLASS 	<ul style="list-style-type: none"> ● Nothing

Notes:

- Spent the class learning about the basics of ASP, important qualities to possess in order to succeed in ASP
 - Notes taken below:

Important ASPects:

1. Planning
2. **Time-Management**
3. Task-Tracking
4. **Communication**
 - a. CC ASP coordinators (Dr. Garcia + Ms. Kale) when emailing mentor + supervisor
 - b. Reply ASAP (< 2 hours, preferably)
5. **REALLY IMPORTANT:**

a. *After a meeting with a mentor, email them regarding the tasks that you have set out for yourself (or that have been set out for you), and try to complete them by the next meeting or applicable due-date*

i. *Ask “Have I missed anything?” at the end of the email, just in case*

6. Calendar

a. Note down all ASP classes a month in advance

b. Note down all work to be done in those class blocks, a month in advance

i. Setting deadlines for yourself – be kind, but not too kind

CYSF

1. Top 15 Projects (JH/SH) admitted to CYSF

a. Around 10 ASP projects admitted every year

b. Won't make or break grade, but can impact it?

Logbook

1. Used to track **notes (daily or with mentor)**, work, data-collection, basically everything ASP-related

a. Should retroactively include work done during the summer

Grading

1. Assessments every other week, regarding **communication + schedule**

2. **Logbook** – Calendar, Tests, Results, Work, EVERYTHING (20% total)

3. **Oral Presentation** – 4 major presentations throughout the year, w/ different weightings (30% total)

a. Research Proposal

b. Preparation for Science Fair

c. Science Fair Presentation

d. Final Presentation

4. Written Work – Papers / write-ups (30% total)

a. Research Proposal

b. Introduction

c. Experimental Proposal

d. Results

e. Analysis


f. Final Edited Paper

9/3/2025

Tasks To-Do:

Tasks Completed:

- Create a rudimentary Calendar, Daily Notes section, and Title Page in Logbook

- Completed Status-Check
 -  Arvind Raj - ASP Status Up...
- Decided on Logbook-Style
 - Online Logbook

Notes:

- Spent the class learning more about the ins and outs of ASP, specifically how to properly structure our logbooks and research proposals
 - Notes taken below:

Logbook

- Digital (Google Docs / Word)
 - Use tabs to organize your logbook
 - Title page for your logbook
 - Calendar for your logbook
 - Full month laid out in advance – specific tasks for each class
 - Meetings laid out, as well
 - Example: for project proposal, list “edited project proposal, correcting grammatical errors and increasing brevity, then sent to mentor for back-and-forth editing”
 - Background Research
 - Should be in-depth
 - Should be completed, using proper, effective literature on the subject-matter
 - Papers
 - Have to record the entire drafting-writing process of in-class papers
 - Research Proposal, Experimental Proposal, Results, etc.
- Physical
 - Much more vaguely covered
 - Much more difficult to maintain organization with – that is alright
 - Main necessity is substantial information
 - “Crowding the pages”
 - Need to include snippets of papers inside of the logbook?

Research Proposal

- Listen to your mentor in terms of format
 - Also listen to Dr. Garcia and Mrs. Kale – they will be grading us
- Guidelines for Research Proposal posted
 - Figure out whether or not your project will be an experiment, study, or innovation-type
- Research Proposals are important in all stretches of research
 - Gets research funded (grants)

- Gets approval from peers (abstracts)
 - Abstracts are basic data summaries – incomplete, but a preliminary product
- Main purpose of this proposal:
 - Answer: “How does using this technique / methodology answer the question in the best manner?”

9/5/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Fill in Daily Notes section with Summer & Late August / September information ● Fill in Calendar with September information 	<ul style="list-style-type: none"> ● Created a Calendar Template, for both current and future use ● Created a Daily Notes template, for both current and future use ● Created a Title Page for Logbook

Notes:

- The class was portioned into two parts; the first was a lecture regarding expected communication with both mentors and teacher-advisors for ASP, and what sites to use in order to properly perform research for our projects – this took about 45 minutes
- The second part was free worktime, which I used to frame and structure my ASP logbook, completing my Title Page, Daily Notes template (not information), and Calendar Template (not information) – this was for about 45 minutes, until class ended (1h 30min block)
 - Notes taken from the lecture are below:

Summary of Lecture

- Dr. Garcia went over classtime-meeting-minutes (time breakdown)
 - Expected format / procedure for logbook creation + management
 - Emphasis on communication both with mentors and Project supervisors (Dr. Garcia & Mrs. Kale)
 - Went over sites for peer-reviewed paper and literature
 - PUBMED (NCBI)
 - For me, as I have a bio-related project
 - Received information about other sites for consolidating research and papers
 - Medline, for example

- On Thursday, we will be gaining access to “PaperPile,” a web-based Reference Manager
 - Should help with consolidating / tracking sources used for research

9/9/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Fill in Daily Notes section with Summer & Late August / September information 	<ul style="list-style-type: none"> ● Filled in Calendar with September information

Notes:

- Worked on inputting information into my Calendar, and attempted to put Summer notes into my Daily Notes section – cut short, however, because of meeting
- Had a meeting with Mrs. Kale and Dr. Garcia regarding my progress with my ASP so far (took about 30-45 minutes)
 - Notes Taken Below:

09/09/2025

1. Narrow Question
 - a. Make it something answerable
 - b. Something that you can corroborate, using the data
 - i. Create one by the next meeting with Dr. Sheldon, both for the systematic review and for my ASP
 - c. Positive or null hypothesis
2. Need to forward all of the emails with Dr. Sheldon
3. Need a summary of the tasks that I am working on this week
4. Research Proposal:
 - a. Broad definitions and descriptions of Stretch-Induced Syncope, at the beginning, to narrower, later in the paper
 - i. Syncope → Related Disorders → History, etc.
 1. Present controversy with Benditt Paper, or lack of cohesiveness / entirety in tests
 - b. Explain Methodology of Testing + Analysis

- i. Stretch-Test-Maneuver
- ii. Using MATLAB & MiniP, along with SPSS


9/11/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Fill in Daily Notes section with Summer & Late August / September information ● Find 5 Papers to Use for Background Research, and Cite Them Using PaperPile 	<ul style="list-style-type: none"> ● Installed PaperPile ● Learned How to Operate PaperPile

Notes:

- This class was entirely dedicated to learning how to install, manage, and operate PaperPile, a reference-managing software
- Learned the different, most-applicable reference-styles (i.e. AMA, APA)
 - APA will be used by me, as I have a study-type project
- Had minor trouble gaining access to PaperPile, but was sorted out, and can use it perfectly well now

9/14/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Fill in Daily Notes section with Summer & Late August / September information ● Create an Update on My Systematic Review Progress (Will be Addressed During Meeting) 	<ul style="list-style-type: none"> ● Found 5 Papers to Use for Background Research, and Cited Them Using PaperPile ● Created an Update-Reporting Template for Dr. Sheldon <ul style="list-style-type: none"> ○  Arvind_Raj_UpdateTempla...

Notes:

- Dr. Sheldon had previously reached out to me and asked me to create 2 things before our next meeting:
- 1. Update-Recording template for my Stretch-Induced Syncope ASP, that could be used to track progress on the number of patients that had been stretch-tested, number of files that I have analyzed, the number of files that have been cleaned, etc.
 - This was finished, but doesn't have any data (I can't access the files because my University of Calgary account was randomly locked)
- 2. Systematic Review progress update – an update on what I have done so far for my Systematic Review, future steps & goals, and what I will do to reach them
 - Need guidance from Dr. Sheldon regarding my Systematic Review, so held off on creating something that would likely only be counterproductive
 - Instead, I prepared to ask him about my Systematic Review, during our meeting tomorrow

9/15/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none">● Finish Daily Notes up to present● Add more information to Update Recording Template (With Rashmin's Assistance)● Complete a Half-Page Systematic Review Update	<ul style="list-style-type: none">● None

Notes:

- Had a meeting with Dr. Sheldon regarding my Stretch-Induced Syncope progress so far, organization for my project, future steps for my Systematic Review, and Dr. Sheldon's future availability
 - This took the majority of classtime
 - Meeting notes: [Arvind Raj - Meeting Update With Dr. Sheldon - 09/15/2025](#)
- For the rest of class, I attempted to catch up on some of the tasks that I had pending
 - I reached out to Rashmin, and asked her if she could get back to me with data to fill out the Update-Recording Template, and to gauge the accuracy of what was already present

- I began thinking about what exactly I had in mind for my Systematic Review
 - I.e. Specific Question, Screening Process for Articles, Sources, Goals / Timeline

9/17/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Finish Daily Notes up to present ● Fully Complete Systematic Review Update 	<ul style="list-style-type: none"> ● Added more information, populating columns, for Update Recording Template (With Rashmin's Assistance) <ul style="list-style-type: none"> ○ Arvind_Raj_UpdateTempla... ○ Sent my final copy to Rashmin, who reviewed it, and in turn sent it to Dr. Sheldon ● Finished Summer Research Notes

Notes:

- Spent the class working on tasks
- Updated my calendar, corresponded with Rashmin, and worked on my Logbook notes
- Worked a part of my Systematic Review Update (Question-narrowing)
- Began reviewing papers on Stretch-Induced Syncope, gaining a better scope of knowledge for the current base of information
 - There is not all that much available, however; Stretch-Induced Syncope is uncommon and poorly understood – more research is being done, and my ASP is a step in that direction

9/19/2025

Tasks To-Do:	Tasks Completed:

<ul style="list-style-type: none"> ● Finish Daily Notes up to present <ul style="list-style-type: none"> ○ Now a major priority, to be done soon 	<ul style="list-style-type: none"> ● Systematic Review Update Finished <ul style="list-style-type: none"> ○ Sent to Rashmin, and she said that she would take a look at it
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Notes:
<ul style="list-style-type: none"> ● Had a meeting with Mrs. Kale, regarding my status on my ASP <ul style="list-style-type: none"> ○ Primarily discussed future assignments, managing what I currently have on my plate, and specificity regarding my methodology for my project ○ Notes are below: <p style="text-align: center;"><u>09/19/2025</u></p> <ul style="list-style-type: none"> - Research proposal to be done soon <ul style="list-style-type: none"> - Editing process between self and mentor, so send rough draft a week or 2 in advance - Things to think about: <ul style="list-style-type: none"> - How to analyze data? <ul style="list-style-type: none"> - What tools used? - Define short-term & long-term goals - Read papers (more literature) - Determine project methodology <ul style="list-style-type: none"> - Clarify, specifically - Finish Logbook very soon

9/23/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● FULLY complete Daily Notes to present ● Read All Papers for Background Research for Research Proposal 	<ul style="list-style-type: none"> ● Substantial work to Daily Notes section (4 classes / recordings) – takes quite a long time, and should keep up with it better, going forwards

Notes:

- Spent the class primarily working on my Daily Notes section, and attempting to ensure that it is fully up-to-date
- Finished 4 classes in September – need to finish the rest

9/25/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Complete Background Research for, and Begin Writing, Research Proposal ● Create a “Milestones” Document for Both the Systematic Review and Stretch-Induced Syncope Project ● Begin additional recruitment for Stretch-Induced Syncope project (outside of AFTs) 	<ul style="list-style-type: none"> ● Completed Daily Notes Section <ul style="list-style-type: none"> ○ Now up-to-date

Notes:

- Had a meeting with Dr. Sheldon, for the first half of class
- After our meeting, I worked on the Daily Notes Section, almost fully completing it
 - Completed it outside of school hours
 - Now up to date on Daily Notes, need to shift focus to Research Proposal
- Meeting Notes: [☰ Arvind Raj - Meeting With Dr. Sheldon - 09/25/2025](#)

9/29/2025

Tasks To-Do:	Tasks Completed:

<ul style="list-style-type: none"> ● Complete Background Research for, and Begin Writing, Research Proposal ● Create a “Milestones” Document for Both the Systematic Review and Stretch-Induced Syncope Project ● Begin additional recruitment for Stretch-Induced Syncope project (outside of AFTs) 	<ul style="list-style-type: none"> ● None
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Notes:	
<ul style="list-style-type: none"> ● Dr. Garcia began class by describing how to approach mentors with the research / papers we have completed and read <ul style="list-style-type: none"> ○ She further discussed how our notes should be framed in our Logbooks <ul style="list-style-type: none"> ■ With sources, and not just solely in PaperPile ● Meeting With Mrs. Kale (Rest of Class) <ul style="list-style-type: none"> ○ Notes Taken: Meeting With Mrs. Kale - 09/29/2025 	

10/01/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Complete Background Research for Research Proposal ● Create a “Milestones” Document for Both the Systematic Review and Stretch-Induced Syncope Project ● Organize Meetings With Dr. Sheldon and Rashmin for the Next 2 Months ● Regain Access to Outlook ● Determine Whether or Not Additional Support is Required for ASP 	<ul style="list-style-type: none"> ● Regained Access to Outlook ● Determined That Additional Support is Required for ASP

Notes:

- Today, I was able to catch up on a few pending housekeeping tasks. I first regained access to my Outlook account, which was previously barring me from proper, efficient communication with both Dr. Sheldon and Rashmin. I was able to gain full access to my University of Calgary email, Outlook Calendar, and the entire Microsoft Suite, as well, as my U of C account entails.
- Then, using my progress over the past month as a litmus, I attempted to determine whether or not additional support was required for my Applied Science Project. Dr. Sheldon has recently become increasingly busy, and is unable to provide me with as much help as is convenient in a reasonable time frame, which is understandable – his job requires copious amounts of international travel for conferences and meetings, and his shifts in the hospital, along with his additional research, are taking up even more of his time than a month ago. Rashmin is getting bogged down with work, as well, and is having some trouble finding the time to correspond with me. It takes days for her to respond at times, and this will provide me considerable trouble in the future, if left unchecked. With this in mind, I believe that additional, on-the-ground support is required to allow me to succeed and progress effectively in my project. I will be searching for this support over the next few days.

10/03/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Complete Background Research for Research Proposal ● Create a “Milestones” Document for Both the Systematic Review and Stretch-Induced Syncope Project ● Organize Meetings With Dr. Sheldon and Rashmin for the Next 2 Months ● Find, And Organize a Meeting, With Additional Support for ASP 	<ul style="list-style-type: none"> ● Organized Meetings With Dr. Sheldon and Rashmin for the Next 2 Months ● Found and Contacted Additional Support for ASP – Priyanshu Giri

Notes:

- Listened to a lecture by Dr. Garcia regarding reference styles; contemplated swapping from APA to AMA, as AMA is more relevant to the medical nature of my project, and citations in AMA would likely be more convenient to administer than in APA.
- Set up Calendar Invitations with Dr. Sheldon and Rashmin for the next two months, using my now-functional Outlook account (and the built-in Microsoft Teams feature). Dr. Sheldon was online as I did this, and accepted all of the meetings. Rashmin, a few hours later, accepted one of them (10th of October), but was tentative or declined a few (declined the 20th of October, tentatively accepted the 27th of October, 3rd of November, and 24th of November).
- Ended up deciding to request additional support on my project from Priyanshu Giri, a 3rd-year undergraduate student studying Biology at the University of Calgary. He works, as a student,

with Dr. Sheldon, and I had the pleasure of working with him in great excess over the summer (he was my “mentor,” for learning the ropes as I worked around the lab). He is highly capable, very organized and disciplined with a great work ethic, and is familiar with Stretch-Induced Syncope, as a result of working with Dr. Sheldon – very few people know anything about the subject, so this puts Priyanshu far ahead of others, as well. I contacted him via my University of Calgary email, and asked to set up a meeting to discuss my project, future steps, and whether or not he is able and willing to help me. Still awaiting a response.

10/07/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Complete Background Research for Research Proposal ● Create a “Milestones” Document for Both the Systematic Review and Stretch-Induced Syncope Project ● Begin additional recruitment for Stretch-Induced Syncope project (outside of AFTs) 	<ul style="list-style-type: none"> ● Began additional recruitment for Stretch-Induced Syncope project (outside of AFTs)


Notes:

- Had a meeting with Mrs. Kale regarding my progress so far for my ASP, and future steps, along with things that I need to do / figure out:
 - Meeting With Mrs. Kale - 10/07/2025
- I emailed Rashmin to inquire about additional recruitment (outside of AFTs) for the Stretch-Induced Syncope project. I asked about the demographics of who we would be selected (age-matching, sex, socioeconomic status, race), and whether or not we could recruit patients from a below-18 population. She responded to me later in the day, stating that we would not be age-matching or accounting for demographics significantly, and we could not recruit people below the age of 18 (as per the protocol for more-efficient stretch-testing that recently passed through the University of Calgary Research Ethics Board). Instead, we will be recruiting students at the University of Calgary, and be providing participants with \$20 compensation (approved by Ethics). Rashmin further stated that she will sort out the recruitment herself, as she works at Foothills / the University of Calgary, and will have easier access to a lot of potential patients.
- Priyanshu responded to my previous email, and said that he could meet with me at 6:30 P.M. on October 8, and that we could discuss my project and his availability / ability to work with me then. We set up a meeting on Outlook Calendar.

10/08/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none">• Complete Background Research for Research Proposal• Create a “Milestones” Document for Both the Systematic Review and Stretch-Induced Syncope Project• Email Priyanshu Specific REDCap Fields for Stretch• Download LabChart Reader• Set up a Covidence Account	<ul style="list-style-type: none">• Downloaded LabChart Reader


Notes:

- Met with Priyanshu at 6:30 P.M. today, regarding him potentially being a figure of additional, ground-level support for both my Systematic Review and Stretch-Induced Syncope Project. Although he is extraordinarily busy, between long hospital-volunteering shifts, tutoring, and finishing 3rd-year Biology (major) coursework, he agreed to help me, and to be there for me whenever he has an opportunity. However, he insists that I stay organized, on pace for my timeline for both projects, and inform him about the tasks that I need to complete and have already completed. I debriefed him on the specifics of my projects, and he gave me a few tasks to complete, and information on where he believes my projects (particularly the Systematic Review, as he completed one about a month ago), should be going. The notes that I took from the meeting are below:
 -  Meeting Notes With Priyanshu - 10/08/2025

10/09/2025


Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none">• Complete Background Research for Research Proposal• Create a “Milestones” Document for Both the Systematic Review and Stretch-Induced Syncope Project	<ul style="list-style-type: none">• Created a “Milestones” Document for Both the Systematic Review and Stretch-Induced Syncope Project

<ul style="list-style-type: none"> ● Email Priyanshu Specific REDCap Fields for Stretch ● Set up a Covidence Account 	
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Notes:	
<ul style="list-style-type: none"> ● Today, I primarily focused on creating accurate, realistic Milestones for both my Systematic Review and Stretch-Induced Syncope Projects. This took a lot of time and effort, and ended up occupying my entire class block, not allowing me work time for my Background Research for my Research Proposal, which is what I sought to use at least a portion of the class for. The document, which will continue to be updated over time (based on new tasks, changes in deadlines, etc.) is below: <ul style="list-style-type: none"> ○  AR Milestones_20251009 v2.xlsx 	

10/10/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Complete Background Research for Research Proposal ● Email Priyanshu Specific REDCap Fields for Stretch ● Set up a Covidence Account ● Begin File Analysis 	<ul style="list-style-type: none"> ● Emailed Priyanshu Specific REDCap Fields for Stretch ● Set up a Covidence Account

Notes:	
<ul style="list-style-type: none"> ● Had a meeting with Dr. Sheldon today; it was primarily a catch-up / regroup session between Dr. Sheldon, Rashmin, and myself (Priyanshu, due to his schedule, will never be able to make / be invited to these meetings). I was informed that David Benditt, our major “rival” in the Stretch-Induced Syncope Research-Race, is beginning a new experiment, and it could impinge upon the data that we are currently collecting & analyzing. With this in mind, Dr. Sheldon wants me to analyze files quickly, and a few before our next meeting, in order to determine whether or not the stretch that we are currently making patients perform is leading to induced hypotension (both standing and supine). Otherwise, we will have to change the maneuver, and change it quickly. Meeting notes below: <ul style="list-style-type: none"> ○  Meeting With Dr. Sheldon - 10/10/2025 ● I set up a Covidence Account, which I was provided through the University of Calgary Organization – Covidence is a resource / website to aid with the literature screening and reviewing process for Systematic Reviews. After creating my profile, I created a new project 	

(for the Systematic Review), and invited Priyanshu and Rashmin as collaborators. I created a preliminary inclusion & exclusion criteria list to guide the screening process, and left the project there for the time being.

- After speaking with Dr. Sheldon, I was able to send Priyanshu the specific REDCap fields for the Stretch-Induced Syncope project, based on the parameters of the hemodynamics that we're testing for. Priyanshu approved of these REDCap fields, and assumedly implemented them into the REDCap software.

10/11/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> • Complete Background Research for Research Proposal • Perform a Full Literature Search on Multiple Databases • Import Research Papers into Covidence 	<ul style="list-style-type: none"> • Performed a Full Literature Search on Multiple Databases • Imported Research Papers into Covidence

Notes:

- I performed a full literature source of multiple scientific databases (NIH, MEDLINE, Embase, CINAHL, Scopus / Elsevier, & Web of Science), extracting over a thousand total files (including overlap) from the databases. The documentation of my search is provided below:
 - [W AR Stretch-Induced_Syncope_Information_Documentation 20251014 v2.docx](#)
- I then imported all of the files that I extracted into Covidence. Covidence automatically excludes duplicate papers, and provides an easy, accessible way to perform screening and full-text review for all members of the Systematic Review.
- I gathered 9 papers, relevant to both Stretch-Induced Syncope and general Syncope using NIH, and added them to PaperPile, along with beginning analysis / "research" on them. I completed 4 papers worth of research, which are denoted as papers 1-4 in the following document:
 - [W AR SIS_Background_Research_ASP_FINAL 20251014.docx](#)

10/12/2025

Tasks To-Do:	Tasks Completed:

<ul style="list-style-type: none"> ● Complete Background Research for Research Proposal ● Complete Paper-Screening for Systematic Review <ul style="list-style-type: none"> ○ Screen 150 papers per day, until done 	<ul style="list-style-type: none"> ● Completed Background Research for Research Proposal ● Screened 150 papers
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Notes:
<ul style="list-style-type: none"> ● I completed background research on the other 5 papers that I collected, labelled 5-9 in the document above. ● I began screening papers for my Systematic Review – screening has 3 different people involved: 2 primary screeners, and 1 tiebreaker. Priyanshu and myself were the primary screeners, and Rashmin was the tiebreaker, based on the time that each of us had available (I would always be a primary screener, though, as it is my Systematic Review). The 2 primary screeners have to look at the titles and abstracts of each paper in Covidence, and vote either “yes,” “maybe,” or “no” to keep the paper, based on relevance to the Systematic Review. The two primary screeners have to perform this process independently of one another, and will therefore likely have conflicts, where one person decides to include a paper that the other decided to exclude. In this case, a tiebreaker will review the conflicts, and decide whether or not to move the conflicts forward into the full-text review stage. Just as a note, I will be screening 150 papers per day until the screening is done (in 7 days) – I will not put some of these days in the Daily Notes, because nothing else will be happening during them.

10/13/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Complete Paper-Screening for Systematic Review <ul style="list-style-type: none"> ○ Screen 150 papers per day, until done ● Complete Introduction for Research Proposal 	<ul style="list-style-type: none"> ● Screened 150 papers

Notes:

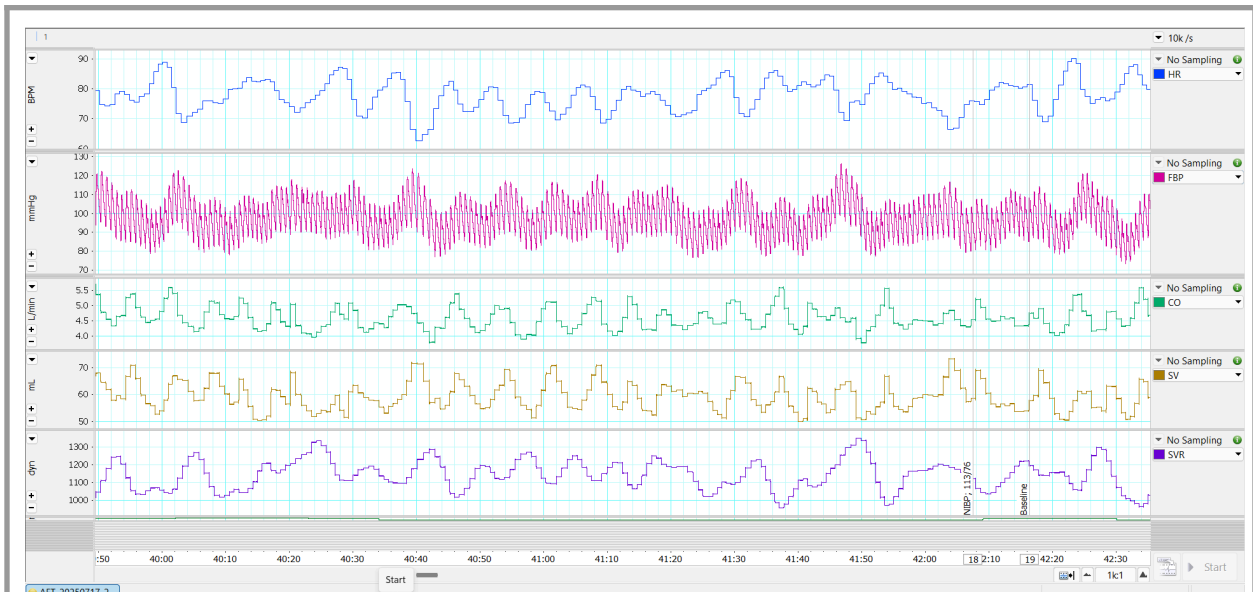
- Today, I began writing my Introduction Section for my Research Proposal. This will include sections such as "Syncope," "Reflex Syncope," "Situational Syncope," "Stretch-Induced Syncope," and a "Timeline of Modern Stretch-Induced Syncope Research (1990 Onwards)"
 - This will be one of, if not the longest section of my entire Research Proposal
- I finished the sections of "Syncope," "Reflex Syncope," and "Situational Syncope" – all of the other Introductory sections still need to be completed

10/14/2025

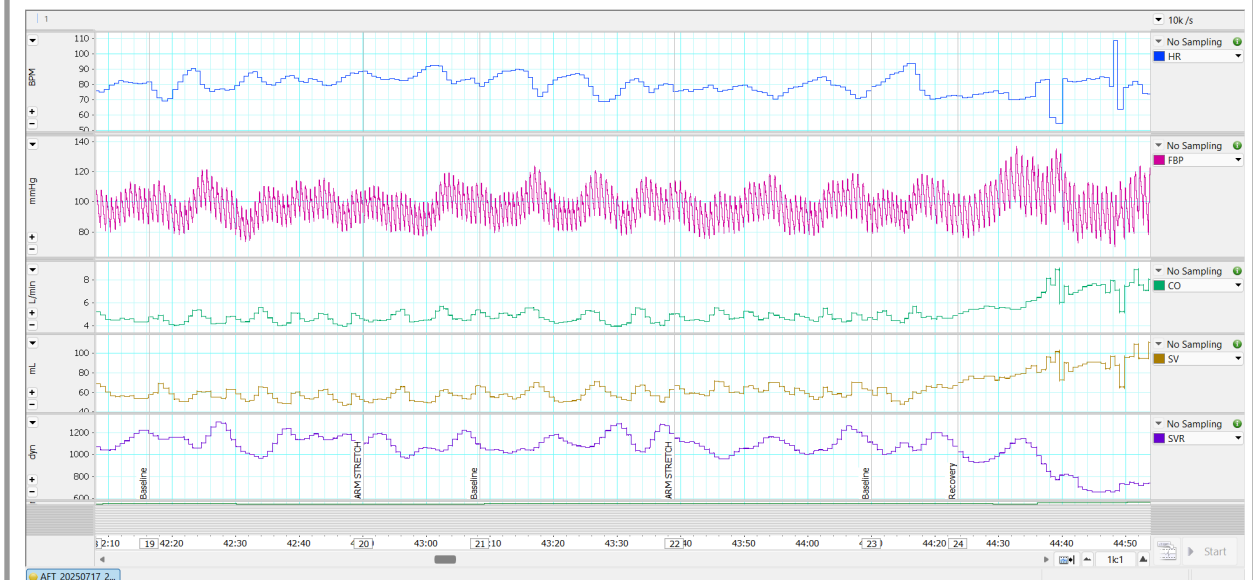
Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Complete Paper-Screening for Systematic Review <ul style="list-style-type: none"> ○ Screen 150 papers per day, until done ● Complete Introduction for Research Proposal ● Analyze a Healthy Control Patient File (Stretch-Induced Syncope Project) 	<ul style="list-style-type: none"> ● Analyzed a Healthy Control Patient File (Stretch-Induced Syncope Project) ● Screened 150 papers

Notes:

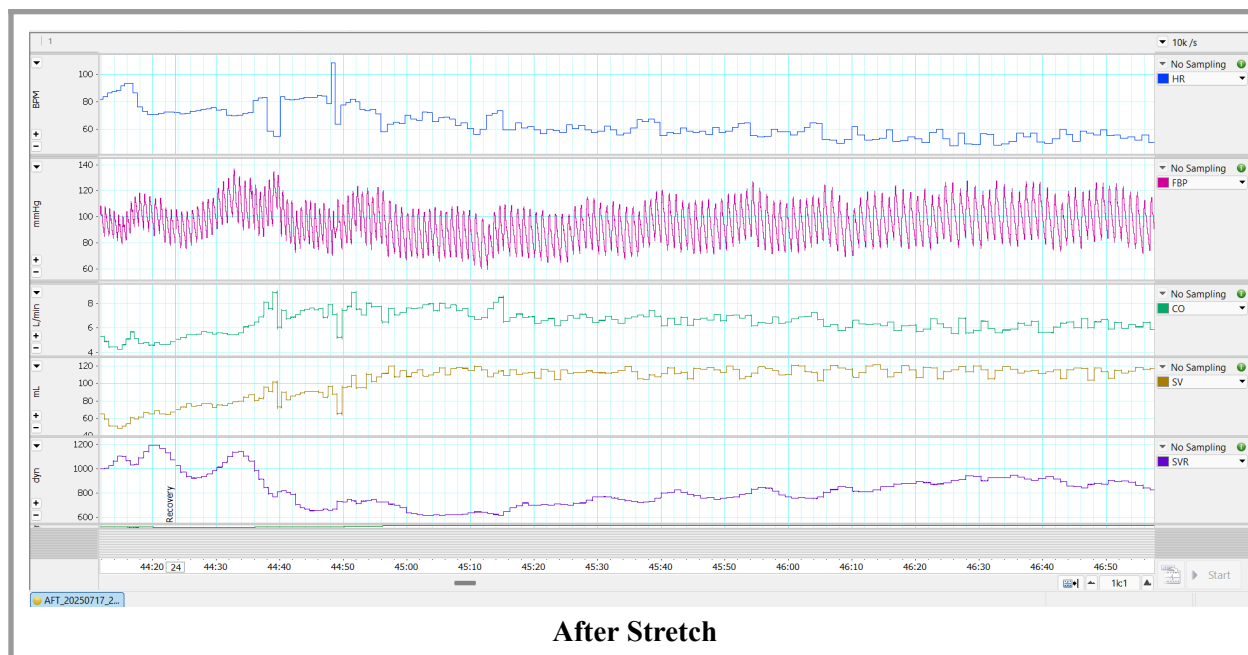
- Completed Stretch-Induced Syncope "Timeline" sections for Pelekanos et al., Sturtzenegger et al., and Sarrigiannis et al..
- Analyzed one file from a healthy control patient, and I believe that there is a signal that shows that performing the stretching maneuver triggers a minor hypotensive response – this is exactly what we want to see, and will inform Dr. Sheldon about this during our next meeting.



Before Stretch



During Stretch



10/16/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Complete Paper-Screening for Systematic Review <ul style="list-style-type: none"> ○ Screen 150 papers per day, until done ● Complete Introduction for Research Proposal ● Ask Rashmin to Send Over the Specific Methodology for the Stretch-Induced Syncope Testing 	<ul style="list-style-type: none"> ● Completed Research Proposal Introduction ● Asked Rashmin to Send Over the Specific Methodology for the Stretch-Induced Syncope Testing – awaiting a response ● Screened 150 papers

Notes:

- Today, I fully completed my Research Proposal Introduction, finishing off the final sections. I rounded off the Timeline with Mercante et al. and Kosmopoulos et al., and then added a section regarding the relevance & necessity of the research that is being performed.
- I additionally sent a message to Rashmin, asking her to please send over the specific methodology for Stretch-Induced Syncope testing, as was recently approved by the University of Calgary Research Ethics Board. I would like to receive this ASAP in order to begin working

- on the “Methods” section for my Research Proposal (due on October 22, or in 6 days)
- Had a meeting with Mrs. Kale, primarily regarding the logistics / specifics of the oral presentation that will proceed the Research Proposal – the meeting notes are below:
 - [Meeting With Mrs. Kale - 10/16/2025](#)

10/20/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Complete Objectives and Significance Sections for Research Proposal ● Acquire Specific Methodology for Stretch-Induced Syncope Testing from Rashmin ● Ask Dr. Garcia for an Extension on Research Proposal 	<ul style="list-style-type: none"> ● Completed Paper-Screening for Systematic Review (Yesterday) ● Receive Extension on Research Proposal

Notes:

- I was supposed to have a meeting with Dr. Sheldon today, but he was put on Green Service (hospital service) suddenly, less than 15 minutes before our meeting. He took over the hospital shifts of another doctor whose father is having severe medical issues right now, and because of that, Dr. Sheldon’s schedule is very packed and subject to random changes, right now.
- I asked Dr. Garcia for an extension on my Research Proposal. I asked Rashmin for the specific methodology for stretch-testing 4 days ago, and followed up multiple times, but received no response – Rashmin was supposed to travel on the 19th, and not before that, so I am unsure as to why she has not been responding to me. She could be very busy, although I would at least appreciate it if she were to tell me that. Now, I am unfortunately unable to progress further with my Research Proposal (due to a lack of certain methodology), which led me to ask for an extension. I still don’t have the methods, and the Research Proposal is due in 2 days, which would not provide me with enough time for a full editing process, even if I did have the methods. I take the blame for quite a lot of this situation – I will attempt to plan better, and more in advance, ahead of this next due date.
 - Future Note: I spoke to Dr. Garcia about the specifics of my extension, and she said that my Research Proposal is now due on November 3, and my Oral Presentation is on November 6

10/24/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Complete Objectives and Significance Sections for Research Proposal ● Complete Research Question, Hypothesis, and Variables Sections ● Complete Methods Section ● Complete Oral Presentation 	<ul style="list-style-type: none"> ● Acquired Specific Methodology for Stretch-Induced Syncope Testing from Rashmin (October 21) ● Completed Objectives and Significance Sections for Research Proposal

Notes:
<ul style="list-style-type: none"> ● Today, I completed my Objectives and Significance sections for my Research Proposal. On October 21, Rashmin was able to get back to me with the specific methodology for Stretch-Induced Syncope testing. ● I had a meeting with Mrs. Kale today, as well. It was just an opportunity for me to provide Mrs. Kale with information about where I am with my project and how I am doing, and I was not provided with any new, pertinent information. For that reason, there were no notes taken, and there is not a notes document attached to this text.

10/27/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Complete Research Question, Hypothesis, and Variables Sections ● Complete Methods Section ● Complete Oral Presentation 	<ul style="list-style-type: none"> ● None

Notes:
<ul style="list-style-type: none"> ● Today, I had a meeting with Dr. Sheldon for the first time in over 2 weeks. I updated him on my progress so far with my Systematic Review and Stretch-Induced Syncope data analysis, and he seemed fairly impressed. He appeared particularly happy that I had already completed my Screening Process for the Systematic Review without him having to tell me to do so. I discussed the trends that I believed that I had found in the patient files, and Dr. Sheldon told me to check (and differentiate between) both standing and supine stretches, to determine if this signal / stretching-maneuver is truly effective. Meeting notes are below: <ul style="list-style-type: none"> ○ Meeting With Dr. Sheldon - 10/27/2025

10/28/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none">• Complete Research Question, Hypothesis, and Variables Sections• Complete Methods Section• Complete Oral Presentation	<ul style="list-style-type: none">• None

Notes:

- During this class period, certain students were presenting their Oral Presentations (based on their Research Proposals), and myself, along with others who received extensions, were allowed to quietly work outside of the classroom. I worked on applying some of the edits that Dr. Garcia had provided me with, and developed an appropriate research question along with some rudimentary hypotheses for my Research Proposal. These are unedited and lack precision, so I have not included them under my “Research Proposal” section in my Logbook. I will continue working on, and finish, the remaining sections over the weekend.

11/01/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none">• Complete Research Question, Hypothesis, and Variables Sections• Complete Methods Section• Fix Research Proposal Citations• Complete Oral Presentation Slideshow• Complete Oral Presentation Talking Points• Rehearse Oral Presentation	<ul style="list-style-type: none">• Completed Research Question section• Completed Methods section

Notes:

- Today, with more time at my disposal, I was able to work extensively on my Research Proposal. Rashmin was finally able to get back to me with the methods that I had earlier requested; the methods, approved by the Conjoint Health Research Ethics Board (CHREB) at the University of Calgary, were written by Dr. Sheldon. They are accurate to the experimentation that will be performed, and that I will be analyzing, over the coming weeks. The methods, sent by Rashmin, are below:
 - [W stretch syncope aim 2 June 25 2025 v1ref1.docx](#)
- I was able to slightly adjust, and ultimately settle on an appropriate set of Research Questions and Hypotheses, guided by the newly-sent methods. I still need to expound upon the reasoning behind my hypotheses. I then used these methods to populate the Methods section of my research proposal with appropriate information, slightly adjusting the formatting, style of content, and adding information pertaining to data analysis and structuring of results. I now ultimately only need to complete my Variables section (which will be done tomorrow), and then I will send my completed research proposal off to Priyanshu for a rapid editing process, as I did with him over the summer, and that he agreed to do with me for this project (due to the strict nature of my timeline, which I had little control over). My updated Research Proposal is below:
 - [W AR Research_Proposal_Draft 20251101.docx](#)

11/02/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Complete Hypothesis Variables Sections ● Fix Research Proposal Citations ● Complete Oral Presentation Slideshow ● Complete Oral Presentation Talking Points ● Rehearse Oral Presentation 	<ul style="list-style-type: none"> ● Completed Hypothesis and Variables Sections ● Fixed Research Proposal Citations

Notes:

- Today, I was able to write down appropriate reasoning for my hypotheses, but decided to keep the explanations trim and in a scientific-style, for the sake of conciseness and the overall flow of my Research Proposal. I additionally populated my Variables section, although Dr. Sheldon did not touch on variables whatsoever in the methods paper – when I asked Rashmin and Priyanshu about what I could potentially add for variables, they responded by stating that variables, in the form I was intending (manipulated, responding, and controlled) are rarely used at this level of science. I didn't question them, but I still did have to fill out these sections, as per the requirements of the Research Proposal rubric. They also told me that the age and sex of the patients being tested, in both the healthy control and SIS groups, were confounding variables, as they were not controlled, and could have an unintended, biased impact on the

results of the experiment. I gladly accepted and employed their advice regarding the confounding variables, but generated my own manipulated, responding, and controlled variables. I then edited and properly formatted my paper and citations, and added a title page; then, the paper was sent to Priyanshu for a very rapid editing process, along with the Research Proposal rubric, as we had previously discussed. My final copy of the Research Proposal is attached below:

- [W](#) AR Research_Proposal_Draft 20251103 v2.docx

11/03/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Complete Oral Presentation Slideshow ● Complete Oral Presentation Talking Points ● Rehearse Oral Presentation ● Analyze 10 Stretch Files for Signal 	<ul style="list-style-type: none"> ● None

Notes:

- For the first 45 minutes of today's ASP class, I had a meeting with Dr. Sheldon, during which I showed him screenshots of previously-analyzed stretch files, and he attempted to determine whether or not a signal was produced from stretching while active standing (primarily through identifying acute hypotension in response to the stretch-mechanism). He was unable to identify any meaningful signal from the stretching while standing, which was concerning – 3 patient files were analyzed, and none produced a signal. Dr. Sheldon recommended that we change the stretch-maneuver, before it is too late; when asked to what maneuver we should switch to, he responded that Benditt's shoulder-shrug maneuver produced a signal, and has well-recorded backing through papers and other publications. Therefore, we should move to the shrug-maneuver, and use it as the basis of our research. I am inclined to agree, but I would like to analyze more stretch-files first (about 10), to determine whether there truly is or is not a signal being produced by the current stretch – I told him this, and he agreed to wait, but reminded me that the more time I spend looking for a signal right now, the less time I will have to actually collect data and test patients. Meeting notes are below:
 - [E](#) Meeting With Dr. Sheldon - 11/03/2025
- After the meeting with Dr. Sheldon, I was able to observe the tail-end of Shaayaan's Oral Presentation, during his Q&A section, but missed all of the pertinent information that he shared during his speech. I was then able to listen to Samir's Oral Presentation in full, which I appreciated; it was an enjoyable, informative listen on the impact of diabetes on kidney function in Goto-Kakizaki rats, and gave me insight into how I should perform my own Oral Presentation in a few days – I need to ensure that my slides have VERY little text on them, project well and speak confidently, and stay within the 12 minute time limit (which appears

very easy to accidentally go over).

- Priyanshu got back to me about my Research Proposal and, to my surprise, didn't have any edits for me, and said that it looked good for submission; so, I submitted my Research Proposal, and feel relatively confident about the quality of my final product

11/04/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none">● Complete Oral Presentation Slideshow● Complete Oral Presentation Talking Points● Rehearse Oral Presentation (Minimum 4 Times)● Analyze 10 Stretch Files for Signal	<ul style="list-style-type: none">● Completed Oral Presentation Slideshow

Notes:

- Today I created my entire Research Proposal Oral Presentation Slideshow, in full – it took about 5 hours to complete, accounting for images, pertinent information, graphics, and animations, and basically ate up my entire night, but I am very satisfied with the final product. I have not yet tested it for pacing purposes, so I am unsure as to whether or not it is too long (it's 23 slides, including both a title and ending slide, but some slides move by very quickly, and others less so). Even so, I feel that this presentation sums up my research aptly, and will be a great tool for explaining my project to the class (and it hits all of the necessary rubric-criteria). The presentation is attached below:
 - Arvind Raj - ASP Research Proposal Oral Presentation

11/05/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none">● Complete Oral Presentation Talking Points● Rehearse Oral Presentation (Minimum 4 Times)	<ul style="list-style-type: none">● Completed Oral Presentation Talking Points


<ul style="list-style-type: none"> Analyze 10 Stretch Files for Signal 	
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Notes:	
<ul style="list-style-type: none"> Today, after about 2.5 hours of experimentation (through both ASP class and after school), I was able to iron down the approximate “flow” of my Oral Presentation, and am now confident in how I will speak, and what I will say; I will start with an explanation of what exactly syncope and syncopal disorders are, and then move into explaining the true extent of the dearth of information on SIS. After that, I will go into my Research Questions, Hypotheses, and Variables, and then explain the methodology/instrumentation/analysis of my specific project. I practiced my Oral Presentation to myself 2 times (without timing), and felt that it was of a high quality, and ready for presentation to others; with this in mind, I presented my Oral Presentation to my grandfather, who is not at all well-versed in the subject matter. My logic was such that, if I could explain my project cogently to someone who is entirely unaware of the specifics of my SIS research, then I would effectively be ready to present my project to my classmates, who at least have a baseline level of understanding of my project, from what I’ve told them. My grandfather said that he was able to understand my project very well, and asked me a few questions based around my analytical methods, which showcased his level of interest and the fact that he was paying attention to my presentation. He did, however, comment that I was speaking a little bit too fast for him at times, so pacing is something that I will likely have to work on, moving forward. After talking to Dr. Garcia today, due to having my wisdom teeth removed tomorrow (Thursday) and likely missing next class for the sake of recovery, my Oral Presentation date has been moved to November 13, which is the ASP class after Remembrance Day long weekend. With this in mind, I will practice my Oral Presentation over the weekend, and ensure that my timing is appropriate, as my pace seems to be an issue (which comes with a 23-slide-long presentation). I have not yet timed myself, but I predict that I am about 4-5 minutes over the maximum allotted time (12 minutes) at this point. This needs to be improved over the long weekend. 	

11/11/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> Rehearse Oral Presentation (Minimum 4 Times) Analyze 10 Stretch Files for Signal 	<ul style="list-style-type: none"> None

Notes:

- Today, I circled back to my Oral Presentation after a weekend packed with missed-schoolwork and recovery from my wisdom-teeth-extraction. I practiced 2 times, in full, and timed myself during each – I was over by about 6 minutes during each, which is much more than I initially believed to be the case. I decided to remove all 5 of my slides explaining what syncope is, broadly, and then 3 more, one which was a “transitional” slide from my Variables to Methodology section, one about our recruitment strategy for testing, and one about the specific instrumentation that we would employ; I felt that these slides were extraneous, somewhat limited the flow of my presentation and, first and foremost, just took way too much time to speak over, and required overexplanations that I sought to avoid. The cut slides, which can still be viewed in the original Oral Presentation slideshow, are below:
 -  Arvind Raj - ASP Research Proposal Oral Presentation - Cut Slides
- After cutting these 8 slides (leaving me with a presentation-total of only 15 slides, much less than before), I rehearsed my Oral Presentation 2 more times, each netting good results – I was only 2 minutes over during my first trial, and 1 minute over during my second, and these times accounted for mistakes, stumbles, and other inaccuracies in my presentation that were the result, I believe, of a lack of appropriate practice. I will try to practice, and cut down the time on my presentation, tomorrow.

11/12/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> ● Rehearse Oral Presentation (Minimum 4 Times) ● Analyze 10 Stretch Files for Signal 	<ul style="list-style-type: none"> ● Rehearsed Oral Presentation (9 Times Total)

Notes:

- Today, I rehearsed my Oral Presentation 2 times, in full – I primarily focused on increasing flow and making it entertaining, while appropriately managing my time, and this worked. I was 1 minute under the maximum time of 12 minutes during my first presentation, and was about 30 seconds under 12 minutes during my second trial. During my second trial, I accidentally made a stumble, in the form of an inaccuracy of the explanation of one of my slides – I didn’t stop the timer for this “stumble,” so I believe that this slowed down my overall presentation, and I would have been at about 11 minutes, had I not made this mistake. I feel that my presentation is very solid now, and has no notable flaws; it is entertaining, paced well, and highly informative, which is precisely what I am aiming for. Now, it’s only a matter of making sure that I am calm, explain everything fully, tell a story, and answer questions quickly and appropriately during my Presentation Day.

11/13/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none">● Present Research Proposal Oral Presentation● Analyze 10 Stretch Files for Signal	<ul style="list-style-type: none">● Presented Research Proposal Oral Presentation

Notes:

- Today, at the beginning of ASP class, I presented my Research Proposal Oral Presentation to my peers and ASP teachers for grading. I feel that I did alright, but could have done better, especially considering the results of my extensive practice. Although I typically speak faster and have a lower speaking-time than anticipated when presenting to people / a class, I actually spoke for quite a bit longer than I thought I would, today. I was, yesterday, able to consistently speak for less than 12 minutes, ending at about the 11-minute-mark, but today, for some reason, I spoke for about 14 minutes, going over time by 2 minutes. This was disappointing for me, but not the end of the world – I believe that, noticing some confused looks from certain audience members, I felt an impulse to overexplain certain points, and just was not concise enough in my presentation. I believe that my content-delving and ability to interest the audience were both top-notch, however, so I at least had that to hang my hat on. After ASP class, Mrs. Kale told me that I did a “great job” with my presentation, and Dr. Garcia said that going 2 minutes over was “not a big deal,” so I believe that I should be fine, at least grade-wise, on this project.
- After my Oral Presentation, I had some work time at my disposal, so I attempted to begin analyzing the 10 stretch files using LabChart Reader, but for some reason, the files weren’t opening properly on my laptop, and I spent the rest of the class attempting to effectively troubleshoot the issue. I reset my laptop, fully rebooted the system, and looked up videos on potential problems with LabChart Reader, but nothing was working, so little progress on file analysis was done in this ASP class. At home, I tried using LabChart Reader again, and it worked, which was somewhat strange, but I am happy that it is now working properly – unfortunately, I am busy today (after school), and don’t have time for file analysis. I will have to push it down the road just a little bit further, but still remain aware of the pressing nature of the work.

11/19/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none">● Update Priyanshu and Rashmin on State of Project Progress (SIS and Systematic	<ul style="list-style-type: none">● Updated Priyanshu and Rashmin on State of Project Progress (SIS and Systematic

Review) <ul style="list-style-type: none"> • Update ASP Logbook Calendar • Update ASP Logbook Daily Notes • Complete CYSF Signup • Analyze 10 Stretch Files for Signal 	Review)
--	---------

Notes:
<ul style="list-style-type: none"> • Today, to begin ASP class, I had a meeting with Mrs. Kale, primarily focused on the current level of progress on my ASP Logbook and Calgary Youth Science Fair (CYSF) signup – to this point, I am not well-updated on either, as this week has been inundated with tests, quizzes, projects, and major assessments from other subjects, and I was going through a lot of health issues, prior to this meeting, which occupied a lot of my time and energy. My main takeaways are that I need to update my ASP Logbook as a main priority, and finish my CYSF signup whenever I have a chance, as it shouldn't take very long, and doesn't have to be done immediately. Meeting notes are below (there aren't too many): <ul style="list-style-type: none"> ○ Meeting With Mrs. Kale - 11/19/2025 • After my meeting with Mrs. Kale, I decided that I needed to update (send an email to) Rashmin and Priyanshu as to the potential for our stretch maneuver to be changed, and my requirement to analyze about 10 stretch files to determine whether or not we are picking up an appropriate signal. Neither have responded yet, but I hope this will better keep them updated to the happenings of my SIS research, so that they do not begin testing before I have determined whether or not the current stretch nets us an appropriate signal.

11/20/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none"> • Update ASP Logbook Calendar • Update ASP Logbook Daily Notes • Complete CYSF Signup • Analyze 10 Stretch Files for Signal 	<ul style="list-style-type: none"> • Updated ASP Logbook Calendar

Notes:
<ul style="list-style-type: none"> • Today, I adjusted my November ASP Logbook Calendar to accurately reflect what I have done this month or, more accurately, my timeline for what I expect/expected to get done, and when. This took only about 30 minutes, and I added notes for what I would like to do over the coming week in November, as well, accounting for missing an ASP class due to a President's Breakfast Club presentation (for the entire Senior School). This is one step in the direction of attaining a

fully-updated ASP Logbook. I am unable to fit anything else into my schedule, as I still have a lot of schoolwork to catch up on, although most of my tests are now over for this week (5 total).

11/21/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none">● Send a Weekly Update to ASP Teachers and Mentors● Update ASP Logbook Daily Notes● Complete CYSF Signup● Analyze 10 Stretch Files for Signal	<ul style="list-style-type: none">● Sent a Weekly Update to ASP Teachers and Mentors● Updated ASP Logbook Daily Notes

Notes:

- ASP class began today with a long lecture from Dr. Garcia (about 45 minutes) on the true importance of sending weekly updates to our mentors – I have not been doing this up to this point in time. She stated that it may rectify issues that certain mentors (likely mine included) have had about a perceived “lack of communication” from ASP students, and will also give Dr. Garcia and Mrs. Kale insight into what, specifically, we (students) are doing each week to keep up with our ASP projects. I will now, from this week forward, consistently send a weekly update to my ASP mentors and teachers to keep them aware as to the progress that I am making on my project, and increase the communication between all parties. My first weekly update is screenshotted below:

Weekly Progress Report - ASP & Stretch



Arvind Raj

😊 Reply Reply all Forward

To: bgarcia-diaz@webberacademy.ca; mkale@webberacademy.ca

Fri 11/21/2025 6:53 PM

Cc: Priyanshu Giri; Rashmin Hira; Robert S. Sheldon

Dear Dr. Garcia and Mrs. Kale,

Below is an update on my ASP progress this week:

*Note: Progress this week has been much more stagnant than usual - I had 5 tests this week that required almost all of my immediate attention. Expect greater progress over the weekend.

1. Began preliminary work on Introduction Section, the next major ASP assignment - due mid-December, can be pushed back in order to allow time for research / primary project work.
2. Updated ASP logbook with pre-collected information and notes.
3. Fixed November ASP calendar.

To Do (Over the Weekend):

1. Progress further with full-text review and data extraction (for Systematic Review)
2. Begin Methods for Systematic Review, using PROSPERO (if time permits)
3. Lots of pending schoolwork (Physics, Biology, Chemistry, and Human Geography)

Sincerely,

Arvind

- Before sending the weekly update, I also filled in my missing ASP entries for the month (6, so a lot), and ensured that entries were fully fleshed-out, contained all pertinent information, and had links to referenced documents for accurate record-keeping.

11/24/2025

Tasks To-Do:	Tasks Completed:
<ul style="list-style-type: none">• Analyze 10 Stretch Files for Signal• Complete CYSF Signup	<ul style="list-style-type: none">• None

Notes:

- Today, I had a meeting with Dr. Sheldon. We primarily discussed my current level of progress on my SIS project and Systematic Review – I am behind schedule, which is unfortunate and somewhat concerning, but he emphasized many times that he does not blame me, as he initially believed that I would have more time entirely designated to my ASP projects (4.5 hours per week) during school, than I actually do (free time, essentially). He further stated that I have made good progress on my Systematic Review, and because I don't have much reliance on

anyone else to make progress on the Systematic Review, it should be my 1st-priority project, and that I should drop the SIS project if things go too far off the rails – I am reliant on others to collect data for the SIS project for me, and unless we can determine whether or not the current stretch produces a signal within the next couple of weeks, I likely won't have my data accessible to me by February, for the CYSF. If possible, I would prefer to continue working on both projects simultaneously, which means that I need to analyze the 10 files quickly (although he said that 3-4 files could work, minimum). Meeting notes are below:

- Meeting With Dr. Sheldon - 11/24/2025

12/01/2025

Notes:

- I arranged a meeting with Priyanshu and Rashmin for this Friday (December 5th) from 11:00 to 11:45 A.M.
 - This meeting is primarily intended to provide all three of us an opportunity to regroup, redetermine the direction of the project, and ascertain an approximate timeline for how long data gathering & analysis will, and should, take
 - As it currently stands, due to issues with health and an extreme workload throughout the month of November, I have not achieved as much progress on my project as I would have liked by this point (beginning of December), so regrouping and prompting organization through a meeting between myself, Rashmin, and Priyanshu should be helpful in guiding the ultimate direction of this project

12/03/2025

Notes:

- Dr. Garcia lecture (beginning of ASP block)
 - Complete CYSF Ethics and Due Care form immediately
 - Otherwise, Ethics may not be approved for quite a while (winter holidays)
 - Ensure that Logbook contains SPECIFIC tasks that were / need to be completed, each class
 - Dr. Garcia is beginning to get frustrated at the lack of consistency (with the general class) in writing specific Logbook entries with specific tasks and specifically identifying what we have / need to be doing

- Don't write "work on Introduction Section" – instead, write "Wrote background for papers 1 & 2, and incorporated them into the Introduction Section paper"
- Meeting with Mrs. Kale:
 - Meeting With Mrs. Kale - 12/03/2025
- Completed the CYSF form
 - Filled out both the "Basic Project Info" and "Ethics and Due Care" sections, heavily utilizing my Research Proposal for phrasing / pertinent SIS research details

12/04/2025

Notes:

- Today, I compiled all of the stretch images / signals, both while standing and supine, from the 12, not 10, files that I have access to; Priyanshu added 2 more from November today, so I was able to extract the stretch signals from them, as well
 - Stretch Screenshots 20251204
- Created a document, primarily tracking whether or not the standing stretch signals were present in certain files
 - AR Signal_Analysis_SIS_20251204.xlsx
- I learned today that, according to Sienna from CYSF, since my project involved human participants, I had to complete the rigorous "Significant Risk 2B" form as well, on top of my previously-completed Ethics Due Care 2A form


12/05/2025

Notes:

- Today, I had a meeting with Rashmin and Priyanshu, and we went over where I am with my project, and what I need to do moving forward
- As it currently stands, due to delays with the protocol and testing, it is currently infeasible to test SIS patients; instead, I was recommended to focus on healthy control data that has already been collected via AFTs, and determine the significance of stretching in a healthy population
- Meeting Notes:
 - Meeting With Rashmin and Priyanshu - 12/05/2025


12/07/2025

Notes:

- Today, I created a Powerpoint slideshow, containing my previously-extracted stretch-data-images from the 12 files that have been collected at this point; the intent of this slideshow is to be presented to Dr. Sheldon during our meeting tomorrow (December 8th), in order to verify with Dr. Sheldon whether or not the stretch maneuver that we are using currently works and whether the data looks good, or whether we need to swap maneuvers before it is too late
 -  AR Stretch_File_Images 20251207.pptx


12/08/2025

Notes:

- Today, I had a meeting with Dr. Sheldon about the quality of the stretch signals that I had extracted from the 12 stretch files that have been collected so far; in summary, Dr. Sheldon believes that the signals are (almost) all very significant, and show great hypotension and incredible results, to the eye test, so he was very happy
 - This made me very happy, as well, and fairly relieved, considering the up-in-the-air nature of my project right now (no longer being able to test SIS patients due to feasibility and time issues)
 -  Meeting With Dr. Sheldon - 12/08/2025

12/09/2025

Notes:

- Dr. Garcia lecture (beginning of ASP block)
 - Winter holidays are coming up very quickly, and the way in which ASP students will progress is subject to changing very quickly
 - Some will be in town, and may be able to meet with / work with their mentor regularly over the break
 - Some will go out of town, or may not be able to be in contact with their mentor – progress may be delayed, or may just not occur whatsoever
 - (At least) weekly communication needs to be maintained with mentor, and work should probably get done over Winter Break
 - Communication and work ABSOLUTELY needs to be maintained, even in Midterm season (January) – it is acceptable to be less productive in terms of ASP, but it is entirely unacceptable to get no work done, whatsoever, as Science Fair is at the very beginning of March (only about a month after Midterms)
 - Need to keep updating Logbook regularly, and keep in CONSTANT COMMUNICATION with mentor, always
 - Try to come out of a meeting with mentor with a clear understanding of the tasks that need to be completed
 - Follow-up email to mentor, to ensure that meeting notes are correct, need to be demonstrated effectively
- Meeting With Mrs. Kale:
 -  Meeting With Mrs. Kale - 02/09/2026

12/13/2025

Notes:

Stretch MiniP Code Request

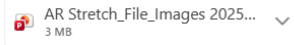


Arvind Raj

☺ Reply Reply all Forward 📎 ⌵ 📅 ⋮

To: 📧 Martin Miranda Hurtado

Sat 12/13/2025 6:04 PM



Hi Martin,

In looking at our Stretch files from the AFTs (work supervised by Dr. Sheldon), there seems to be a pattern that is repetitive: The BP initially goes up transiently, and then the BP falls and then recovers over 5-10 seconds. We would like to parameterize these changes.

Could you help us with software to identify these changes (BP peak, BP nadir, BP recovery to baseline) from baseline (and maybe the changes from BP peak to nadir)? At each of these time points, we would like the full set of hemodynamics parameters (and the changes in these parameters), including SBP, DBP, MAP, HR, SV, CO, and SVR.

We would also like the "Time To" for each of those parameters from the time of stretch. The actual marking for the stretch is not always accurate, so we would need a way to mark this after the fact (can I do that in the LabChart file or in MATLAB?).

I am attaching a PPT file of some of our tracings for you to review to understand what I am trying to describe.

Can this be done in MiniP currently? Would it require tweaking in MiniP and/or the Combine program? If so, how long would it take you to do this?

I am hoping to get the brunt of this analysis done over the Christmas Break, so I am hoping that this would not be too much work for you.

Thank you,

Arvind

- Today, I sent an email to Martin, a coder working with Dr. Sheldon, Priyanshu, and Rashmin, asking for him to create a MATLAB-based code for data extraction from the stretch-data-files
- I am still awaiting a response from Martin, but am not expecting one until December 15th (Monday), because today is Saturday

12/15/2025

Notes:

- Martin responded to my email sent on Saturday, stating that he was occupied for the current moment, and would likely take more than 2 weeks to develop a data-extraction code, which would impede my ability to perform data extraction over winter break; that being said, he referred me to a medical student named Govind, another coder experienced with the MATLAB coding environment, who Martin believed may be able to help, because the code that I am asking for is similar to one that Priyanshu had used earlier (for his Initial Orthostatic Hypotension [IOH] project), which Govind had made
- Govind said that he would be happy to help, and that he would like to meet with me whenever I had the chance; I arranged a meeting time for 6PM on Thursday with him. However, I have my

skepticism about his true ability to help me for my goals of timeliness with data extraction, as he said that he would only be back from a meeting & vacation by December 29th, which is about the same as Martin's (unfortunately) suboptimal timeline

- Govind and Martin both agreed that, in order to properly analyze the files, I would need to fix the faulty comment markers in the LabChart files, and perform signal processing to ensure that the stretch signals were being fully-captured, consistently, and were not subject to duration-error
- Asked, and received an extension for, my Introduction Section Paper until this Friday (December 19th), rather than today (December 15th)
- Meeting with Dr. Sheldon:
 - [Meeting With Dr. Sheldon - 12/15/2025](#)
- Meeting With Mrs. Kale:
 - [Meeting With Mrs. Kale - 12/15/2025](#)
- I reached out to Rasha, the Laboratory Manager working with Dr. Sheldon, in order to gain access to the SIS Informed Consent and anonymity information (for patients' confidentiality)
 - Rasha sought greater clarity, and asked to meet with me, via Zoom, after school today (at about 8:30 P.M.); I sent a meeting invitation to her, and attempted to better explain what I was asking for. This was all in order to gain the materials needed to complete the Significant Risk section of the CYSF portal
 - Meeting Notes With Rasha
 - [Meeting With Rasha - 12/15/2025](#)
 - Rasha sent me the following Informed Consent, stating that this document, along with my SIS Protocol Document, would give me all of the information that I would need for the Significant Risk form (including anonymity information, data sharing, etc.)
 - [ICF Stretch Syncope AIM 2 V1.1 Clean August 26, 2025.docx](#)
 - [stretch syncope aim 2 June 25 2025 v1ref1.docx](#)

12/17/2025

Notes:

- Today, using my Research Proposal Introduction as a base, I fully wrote up (more or less updated) my Introduction Section Paper (as I previously received an extension, it is currently due this Friday, December 19th); I used the feedback that I had previously received on my Research Proposal's Introduction to craft a well-written Introduction Section Paper that properly frames my research, although it is now somewhat outdated due to changes in my project (infeasible to change my Introduction Section Paper right now, with all of the work and major assessments that I have piling up on me right now, 2 days before school is out for winter break)

- [w AR Introduction_Section_Draft_v1 20251217.docx](#)
- I completed all of the writing portions of the Introduction Section Paper, and reformatted my title-region, but did not add any new citations; this is necessary to do at a later date, before submission
- I sent the completed Introduction Section Paper to Dr. Sheldon; he asked to see it before it was submitted, in order to review its quality

12/18/2025

Notes:

- Today, I had a meeting with Govind; not all that much new material (that was not already emailed about) was exchanged during the meeting, but we got to know one another a little bit better, and reaffirm what will likely happen moving forward with the codal-development
 - Martin, today, said that a bunch of time freed up in his schedule, and he would likely be able to start creating the code as soon as I fix the stretch comment markers on the LabChart files
 - Govind still believes that he can only begin working on the code in about 2 weeks, on December 28th; this is still a little bit too late for me, so I likely won't be working with Govind in the long-term. That being said, it was still great to meet him.
- Meeting With Govind:
 - [Meeting With Govind - 12/18/2025](#)

12/19/2025

Notes:

- Dr. Sheldon got back to me after reviewing my Introduction Paper, and briefly said “looks good”, and that it was ready for submission (in terms of the writing)
- I then added the completed references to the end of the paper and for citations, throughout the paper
 - [w AR Introduction_Section_Draft_v2 20251219.docx](#)
- Today was the last day of classes before winter break; I agreed to meet with Priyanshu on Monday to work with him to fix the stretch comment markers, but I'll take Saturday and Sunday easy – I'm incredibly exhausted, especially after this last, incredibly busy week

12/22/2025

Notes:

- Today, I went to Foothills, and began fixing the comment markers using the full version of LabChart, the license for which is only available on a specific computer at the Foothills / on campus
- I finished cleaning one file, but noticed that there were formatting inconsistencies in other files; some didn't label baseline, some had too many baselines, and one had what was clearly a stretch signal, but about 10 seconds before the stretch officially took place. I need to address these issues moving forward, and will need to come back to the University of Calgary to fix these discrepancies at a later time
 - ■ Amyloid AFT_20250904_224-PP (FIXED) 2.adicht

12/23/2025
















Notes:

- Martin emailed me, stating that he had already created a code that he would like to test out on a cleaned file; I sent him the only file that I had cleaned, but informed him that even this file was still a work in progress, and may not be fully representative of my data-cleaning methods in the near future

12/24/2025




Notes:

- Today, I went into Foothills again, and spent basically the full day (9 A.M. to 6 P.M.) fixing / cleaning the collected stretch files. I ensured a consistent procedure was maintained throughout the files (regarding comment markers), renamed all markers appropriately and consistently, and ensured stretches and baselines were of the appropriate lengths

- Martin sent over a code this morning, and I am testing it on a stretch file, and then comparing it to manually-collected values to determine whether or not it works
 -  main.m
 - I had sent over a semi-cleaned file (yesterday) to Martin for reference, and told him that I would provide him with pertinent information today, but he already sent me a code, without requesting my input for what exactly we need to look for and when. This is okay, if it works, but I am skeptical regarding the code's quality for this reason. If the code is not effective, then I will send him my fixed files, and SPECIFICALLY ask for the code to be made in the way that I initially requested
 - I ran the code on some of the files that I cleaned today, and the code does work properly-ish, but only collects values for 3 stretches, while there are 4 stretches for most participants
 - I informed Martin about this issue, and am awaiting a response
- I cleaned the 11 remaining files, and fixed the Amyloid AFT file from December 22nd:
 -  Amyloid AFT_20250904_224-PP (NEW).adicht
 -  AFT_20251022_235-HH (NEW).adicht
 -  AFT_20250929_229-VM PT1, (NEW).adicht
 -  AFT_20251028_233-AH (FIXED).adicht
 -  AFT_20251114_227-AW (FIXED).adicht
 -  AFT_20251014_231-MC PT1 (NEW).adicht
 -  AFT_20250915_228-CM (NEW).adicht
 -  AFT_20251110_234-CC (NEW).adicht
 -  AFT_20250729_220-JT (NEW).adicht
 -  AFT_20250717_219-CA (NEW).adicht
 -  AFT_20250806_223-JK (NEW).adicht
 -  AFT_20250723_218-CT (NEW).adicht
- I created an Excel file, to keep track of the specific issues with the files, which files were missing standing sections, etc.
 -  AR Stretch File Analysis Comments_20251224.xlsx
- I used the following document, the AFT Worksheet that the individuals running AFTs are supposed to abide by, in order to ensure that the files are cleaned accurately and consistently, rather than arbitrarily, based on my own personal judgement
 -  (AR Stretch Fix) AFT worksheet_20251224.docx



12/29/2025

Notes:

- Martin finally responded to my email, and sent a new code; I tested the code, and it worked properly this time, extracting data from a fourth stretch (wherever applicable).
 -  main (1).m
- However, the data was off from what I sought for my project, so I asked him to create a final version of his code, following parameters that I specified; I created an Excel spreadsheet, detailing exactly what parameters I'm looking for in the new code, so that there is absolutely no confusion. I sent this spreadsheet, a cleaned sample file, and a written (email) request to Martin to make changes to his code, following the Excel spreadsheet's parameters as a guide.
 -  AR_Stretch_Manual_Extraction_20251229.xlsx
 -  AFT_20250717_219-CA (NEW).adicht

01/02/2026

Notes:

- Martin finished making his final version of the code, with all of my specifications & parameters implemented
 -  main (2).m
- I tested it out, and it worked flawlessly, extracting all of the stretch data accurately, with all of the stretches included, and to the specific parameters that I requested
- I made the following Excel file, containing all of the data that Martin's code extracted (for all files):
 -  AR_Stretch_File_Data_MartinCodeV3_20260102.xlsx

01/06/2026

Notes:

- I began to work on the CYSF Portal's Significant Risk 2B form, but I realized that I will likely need new materials for the form as, since I am no longer testing SIS patients, I can't use the Stretch Syncope protocol that I asked for the Informed Consent for; I instead need to use the AFT Informed Consent and documentation, as that is the protocol / mechanism that I am employing in order to gain data on healthy individuals
- I will likely hold off on asking Rasha for the AFT Informed Consent and requisite documents

until after my Midterm Exam season is over (January 9-19th)


01/08/2026

Notes:

- Today, due to a rapidly impending deadline for the High School Big Data Challenge (HSBDC) Manuscript, which takes an incredible amount of time, effort, and energy (right before Midterm Exams), I asked Dr. Garcia and Mrs. Kale if, rather than using ASP as a study block for Midterms (as they suggested we do today), I could use the block to work on my HSBDC Manuscript. They obliged, and I was able to make some good progress on the writing section, along with certain members of the rest of my team.

01/11/2026

Notes:

- Dr. Sheldon sent an email to me, asking about my progress – I let him know that, while the Systematic Review is on hold until I complete my stretch project, I have all of the data that I need (using Martin's code on the collected files), and will be running stats soon in order to acquire needed data / values, and later make relevant figures (and write)
- I also requested that we update the meeting calendar for the New Year – midterm exams end on the 20th, and my availability will increase substantially at this point – I informed Dr. Sheldon about this. Got his times back, and sent calendar invitations for the time-slots during which he marked his availability.
 -  Copy of 8 Arvind 2025-26 School-Year Schedule 20250829 (2).xlsx

01/18/2026

Notes:

- I have one last midterm exam tomorrow, but finished most of them last week.
- Sent an email to Rasha asking for the AFT informed consent form (and other pertinent testing documents / worksheets used during AFTs)
- I sent an update to everyone (Dr. Sheldon, Priyanshu, Rashmin, Dr. Garcia, and Mrs. Kale) about my winter break stretch research progress

Update - 1/18/2026



Arvind Raj

☺ ↩ Reply ↩ Reply all → Forward 📎 📧 ⋮

To: 📧 Robert S. Sheldon; 📧 Rashmin Hira; 📧 Priyanshu Giri

Sun 1/18/2026 9:52 PM

Cc: Beatriz Garcia-Diaz <bgarcia-diaz@webberacademy.ca>; Madhavi Kale <mkale@webberacademy.ca>



[AFT_20250717_219-CA \(NEW\) 2.adicht](#)

Hi Everyone,

Below is an update on my ASP progress, over winter break (for those who aren't already aware):

1. All of the stretch files were manually cleaned to fix comment marker placement, stretch duration, comment naming, and ensure consistency in procedural flow. A sample cleaned file is attached.
2. To my specifications, Martin made a code for data extraction, and I ran it on the 12 files that we have, yielding lots of raw data. An Excel file containing all of the collected data is attached.

To Do:

1. I need to run stats (using SPSS) in the near future.
2. I need to begin making figures, after stats are run.

****Note:** Although lots of overall project progress has been made, accounting for winter break, little progress has been made over the last two weeks, due to Midterm exams and preparation; my last one is tomorrow, however, so expect greater progress.

Sincerely,

Arvind

01/19/2026

Notes:

- Today I received the required / pertinent AFT documents from Rasha; I will use these for CYSF Ethics very soon
 - Some of it was not relevant to my project (stretch), but I did still get what I needed, regardless (AFT Informed Consent forms & AFT Protocol)
 - [\[no CPT\] AFT Report TRW Template 2023Sept25.docx](#)
 - [AFT worksheet_2025July22.docx](#)
 - [Autonomic Test Screening Healthy ICF-\(Clean\) V1.14_2025Sept19.docx](#)
 - [Autonomic Test Screening ICF-\(Clean\) V1.13_2025June25 RH SRR \(1\)...](#)

- [W](#) Autonomic Testing Screening Protocol-(Clean) V.11.doc
- [PDF](#) Fatigue VAS.pdf
- [PDF](#) Health Thermometer.pdf
- [PDF](#) mmc2 COMPASS 31.pdf
- [PDF](#) Orthostatic Grading Scale Detailed 2015Aug10.pdf
- [PDF](#) rand36 Survey.pdf

01/20/2026

Notes:

- Dr. Garcia Lecture:
 - Everyone should keep up communication with mentors (I believe that I am doing so appropriately, since she mentioned that, specifically, some people have not spoken to their mentor, or CC'ed Dr. Garcia on emails, since mid-December – I last CC'ed Dr. Garcia and Mrs. Kale on an email to my mentors on Sunday)
 - Methodology Section Due Date: February 19th
 - Specifics of how to write the Methodology Section paper will be described during a later class-block (2 classes in the future)
 - Need to research the precise methodology of the studies that I have observed
 - Send an email to Dr. Garcia before February 12th, with a draft of the Methodology Section attached, in order to receive feedback
 - Pre-Science Fair Oral Presentation Date (For Me): February 23rd
 - This oral presentation is intended to prepare us for our real CYSF presentations
 - Webber Science Fair: March 2nd
 - Should have poster / presentation prepared and ready
 - Can either use a large, school-provided Trifold, or a flat poster, that would need to be manually printed out
 - CYSF Portal: March 4th
 - Needs to be completed by the deadline in order to reach Top 15 status in the city-wide Science Fair
- Had a meeting with Mrs. Kale:
 - [Meeting With Mrs. Kale - 1/20/2026](#)
- Finished and submitted the Significant Risk form, along with editing the Ethics and Due Care form to properly fit the current dimensions of my project

01/21/2026

Notes:

- Ethics was approved by the CYSF Safety Committee, and I gained full access to the CYSF Portal; I will have to add written sections of my project to the CYSF Portal at some point, but it is a much lower priority than actually getting my research (data analysis / statistics) done

01/22/2026

Notes:

- Not feeling well today, so stayed home, missing ASP class and my meeting with Dr. Sheldon (I informed Dr. Sheldon about this)

Update for 1/22/2025 (Replacement for Meeting)

AR Arvind Raj

To: Robert S. Sheldon

Cc: Madhavi Kale <mkale@webberacademy.ca>; Beatriz Garcia-Diaz <bgarcia-diaz@webberacademy.ca>

Dear Dr. Sheldon,

Below are notes on what's going on with my project and things to do:

1. Submitted CYSF (Calgary Youth Science Fair) Ethics and Due Care & Significant Risk Forms, and they were approved. I can now begin working on my Science Fair Portal.
2. I speak to Priyanshu regularly, about once per week (Sunday night), in order to get an idea of where things are on the stretch research project, as he is much more heavily involved now. I am under the impression that we are using the new stretch protocol for ALL subjects, including healthies. Is this the case? We would likely be unable to use our prior healthy data, but that should be fine.
3. I have an MUN conference, occupying me both Friday and Saturday this week, but I intend to run stats on Sunday. Priyanshu has let me know that he's already done some stuff with stats, but I will still run some stats by myself (SPSS).
4. Methodology Section Due Date: February 19th
 - Need to research the precise methodology of the studies that I have observed
5. Pre-Science Fair Oral Presentation Date (For Me): February 23rd
 - This oral presentation is intended to prepare us for our real CYSF presentations
6. Webber Science Fair: March 2nd
 - Should have poster / presentation prepared and ready
 - Can either use a large, school-provided Trifold, or a flat poster, that would need to be manually printed out
7. CYSF Portal: March 4th
 - Including Introduction, Methodology, Results, Discussion, Conclusion, etc.
8. As you can see from the important dates shown above, I have only about 5 weeks to finish analyzing and writing on my healthy stretch data, for the Science Fair. After stats, it's mainly a lot of writing, some of which I have already done. Finishing the Science Fair stuff is probably my biggest priority right now. The Systematic Review will likely be postponed until after March 4th, and the CYSF Portal deadline.

Sorry for being unable to make today's meeting — hopefully this lets you know where I'm at right now, and what my schedule looks like for the future. Please let me know if you want me to do anything, what you think, or if you have any information that you would like to share with me.

Sincerely,
Arvind

- Sent Dr. Sheldon an update email, instead, detailing all of the things that I need to do / have done, and asking some questions about my future project
- Our next meeting is on February 4th, in about 2 weeks

- Sent an email to Dr. Garcia and Mrs. Kale, asking them to swap from Rashmin to Priyanshu for the primary recipient of my monthly Mentor Evaluations
 - Priyanshu is now the most explicitly involved mentor in my project, and the majority of my direct communication is toward him
 - This is primarily due to Priyanshu's involvement with a stretch research course in the new year, under Dr. Sheldon

01/25/2026

Notes:

- Sent an email to Dr. Sheldon, relating to the potential Mentor-Evaluation-Recipient-swap detailed on January 22nd
- Had an MUN conference all day yesterday (Saturday) and from 3 P.M. onwards on Friday (at Henry Wisewood High School, and I won Best Delegate in my committee!)
- Asked Priyanshu to send me demographic data (primarily age & sex) for healthy patients so far, and also for the new healthy files that have been collected through December and January
 - This data is necessary so that I have the full berth of my data available to me, and so that I can run statistics (in SPSS) on my data in the near future

01/26/2026

Notes:

- Dr. Garcia lecture:
 - The methodology is one of the most important sections of the research paper, and ensuring descriptive precision and accuracy, and understanding for the average person, is absolutely pivotal
 - Reading & citing other papers is necessary to provide evidence-rooted descriptions of the specific methods used throughout the course of study
 - Important note: it is necessary to reference the brands / companies that lab-technologies come from (i.e. Finapres NOVA LabChart technology, or LabChart [Location])
 - It is *not necessary* to cite brands / companies that resources are obtained from

- Although ensuring that the average individual can understand the methodology as presented is absolutely vital to the cohesion and effectiveness of the methodology, using specific terminology and making sure that language is not overly simplified, is also key
 - Balancing the two can potentially be achieved through the effective citing of references / papers
- Ensure that the methodology paper is in *past tense* (**was** taken, **were** tested), as the data should already have been / be in the process of being taken
- Methodology paper has to be written in paragraph form, rather than in step-by-step procedure; however, numbers can still be used in the methodology section, for example referring to inclusion & exclusion criteria
- Figures / table are not necessary to be included in the methodology section, and should only be added if they contribute to greater, significant understanding of the specific procedure being highlighted
 - For example, there is no need to insert a figure of a brachial BP cuff or a Finapres NOVA device
 - If included, a figure needs to **be described** before appearing in the paper; it is not acceptable to just show a figure, and then describe “Figure 1” afterwards
- Methodology paper is due on February 19th; it should be completed / sent to Dr. Garcia & Mrs. Kale or mentors by February 12th, at the latest
- Talked to Dr. Garcia and Mrs. Kale about the future directions for my project (over the coming month)
 - As it currently stands, the timeline is going to be relatively short; finishing data analysis (and stats) by February 15th, latest, is necessary, and the Science Fair portal is a last priority (after the poster is completed)
 - I have been allowed to submit the Methodology paper after the CYSF stuff is finished, in order to ensure that my most pressing work is completed

01/28/2026

Notes:

- Have been feeling unwell today and yesterday (some sort of a virus)
 - Dr. Garcia sent over the scoring guidelines for our CYSF presentations. Upon reading these over, I became unclear as to whether or not my project was an experiment or a study. Upon asking Dr. Garcia, I was informed that my project is indeed a study, rather than an experiment, although the line between the two can feel blurry at times.
-

01/29/2026

Notes:

- Got a logbook extension today, from Dr. Garcia (Monday, rather than due tomorrow)
- Prompted Priyanshu on the demographics and new patient files (via AFTs); he said that he would get them to me promptly, so that I can manually fix the files tomorrow and begin statistical analysis (SPSS) the day after
 - He said that we could meet at the Public Library (where he does tutoring) on Saturday (January 31st) in order to teach me how to use SPSS, and to go over what tests I need to run in order to answer my research questions

01/30/2026

Notes:

- Dr. Garcia began class by discussing the necessity to keep on top of our schedule over the next month, as deadlines are quickly approaching
 - Although I have already received an extension for my Methodology Paper (until after the CYSF portal & Webber Science Fair are over), I still need to complete quite a few writing elements for my CYSF portal, complete my statistical analysis (that will be done very soon), make figures, and then create a high-quality poster
 - For the in-class CYSF poster presentation coming up on February 23rd (for me), Dr. Garcia gave the class an approximate breakdown of what should be included, and how much time should be allotted to each section
 - Background on Topic: 1-2 minutes
 - Methods: 2 minutes
 - Results: 4-5 minutes (meat of the CYSF presentation)
 - Analysis & Conclusion: 2-3 minutes
 - The entire presentation should be anywhere from 9-12 minutes, but Dr. Garcia advised that each student aim for approximately 10 minutes (both for time-preservation for Q&A time during in-class presentations, and to ensure interest & flow are retained during actual CYSF presentations)
 - Dr. Garcia additionally advised that we present our ASP posters to others in our lives
 - Teachers who may have some area of specific expertise, relative to our projects (i.e. statistics, specific scientific methodology, etc.)

- Friends / family who have little knowledge on the topic, so that we can ensure that the way in which we frame our research is widely digestible and understandable
- Our mentors or Dr. Garcia / Mrs. Kale themselves, who understand our research on a deep, specific level (and can point out any potential flaws), and for the latter two, are experienced with CYSF judging
- After school, from 7:00 to 9:00 P.M. (after eating dinner), I cleaned stretch files at Foothills (signal processing)
 - Priyanshu sent me December and January files (5 total)
 - 4 had both supine and standing sections, and the data looked significant (from the eye-test), which I was pleased by
 - 📁 AFT_20251201_238-HA (NEW).adicht
 - 📁 AFT_20251209_240-CL (NEW).adicht
 - 📁 AFT_20251215_241-CC (NEW).adicht
 - 📁 AFT_20260122_244-JH (NEW).adicht
 - 1 file only had the supine stretches
 - 📁 AFT_20260114_243-MC (NEW).adicht
 - I also updated my Stretch Comments Excel sheet, outlining all of the issues / missing data with the files that I cleaned
 - 📄 AR Stretch File Analysis Comments (NEW)_20260130.xlsx

01/31/2026

Notes:

- Priyanshu sent over demographic information
 - 📁 ResearchAutonomicTil-SISDemographics_DATA_LABELS_2026-01-31_0316....
- Ran Martin's code on the new, cleaned files and added that data to the overall data spreadsheet
 - 📄 AR_Stretch_File_Data_MartinCodeV3_NEW_20260131.xlsx
 - Added Priyanshu's demographic information to this data spreadsheet
 - 📄 AR_Stretch_File_Data_MartinCodeV3_Demographics_20260131.xlsx
 - All demographic information (age, sex, height, weight, BMI, BSA) were present for all subjects, other than subject 244, whose demographic data has not yet been provided to Priyanshu, although the AFT has been run
 - I sent a message to Rashmin, who is one of the graduate students in charge of AFTs, for this information
- Met up with Priyanshu at the Public Library, and discussed what tests need to be run in SPSS to answer research questions, and why

- [W Stretch Analysis Plan 20260131.docx](#)
- Priyanshu and I spent a long time going over how to properly run stats in SPSS (it wasn't actually that difficult; it just felt like inputting data into a spreadsheet, looking at the data from the tests that were run, verifying their accuracy and validity, and then moving on)
 - Priyanshu was allowing me to use his University of Calgary laptop with SPSS access to practice the tests that we're going to run (both single-armed and paired t-tests on his previously-collected initial orthostatic hypotension [IOH] data), and unfortunately, I did not ask him to save the files that we were working on before he left, so I can't link them here (I asked afterward, and he said that I should have asked earlier, which is fair); that being said, this was a good experience, and time well-spent; I now understand how to use SPSS properly, and am ready to begin running tests tomorrow



02/01/2026

Notes:

- Used my dad's U of C laptop (he is a researcher at the University of Calgary) for SPSS access
- Added demographic data to SPSS, and ran descriptive statistics on them (std. deviations, std. error, mean, medians, etc.)
 - [PDF Stretch Demographics 20260201.pdf](#)
- I ran descriptive statistics for all stretches (L15, L30, U15, U30) at all points in experimentation (baseline, beginning of stretch, during stretch), for all hemodynamic variables (SBP, DBP, MAP, HR, CO, SVR)
 - [PDF Stretch Descriptives 20260201.pdf](#)
- I ran descriptive statistics on the delta values for all hemodynamics (SBP, DBP, MAP, HR, CO, SVR) at nadir SBP; these data could be helpful later for figure-creation
 - [PDF Stretch dSBP Descriptives 20260201.pdf](#)
- Completed Single-Armed T-Tests in SPSS (for all stretches)
 - Ran tests for the first two research questions, which could both be answered through the same single-armed t-tests (One-Group T-Tests)
 - [PDF Stretch One Gp T-Test 20260201.pdf](#)



02/02/2026

Notes:

- I wasn't feeling well today, and ended up going home early from school, but still decided that I needed to continue with my statistics in SPSS
 - Today, I decided to run tests for the latter two research questions (3 & 4), which was a little bit trickier
 - Ran Paired T-Tests (For Parametric Data) & Wilcoxon Signed-Rank Tests (For Non-Parametric Data):
 - For question 3, I used the tests to determine differences (and correlations, although less useful) between supine 15s (L15) & supine 30s (L30), and standing 15s (U15) & standing 30s (U30)
 -  Stretch 15v30 Paired Comparison 20260202.pdf
 - For question 4, I used the tests to determine differences (and correlations, although less useful) between supine 15s (L15) & standing 15s (U15), and supine 30s (L30) & standing 30s (U30)
 -  Stretch LvU Paired Comparison 20260202.pdf

02/03/2026

Notes:

- Rashmin sent over height and weight demographic information for subject 244 (H: 163cm, W: 109kg)
 - I added this to the raw data Excel document, and re-did the demographic statistics in SPSS (again borrowing my dad's U of C laptop)
 -  AR_Stretch_File_Data_MartinCodeV3_FINAL_20260203.xlsx
 -  Stretch Demographics 20260203.pdf

02/04/2026

Notes:

- Upon discussing with Dr. Sheldon, I realized that there had been a miscommunication regarding meeting times and I had actually scheduled all of our meetings for times that Dr. Sheldon marked as “no,” rather than the ones that he was free for (based on a prior colouring system where plum times were his “best guesses” for meeting availability)
 - Dr. Sheldon is on service in the hospital on Wednesday and Friday afternoons
 - Resent meeting invitations, and rescheduled today’s meeting for 11:30 A.M., rather than 2:00 P.M.
- Meeting with Dr. Sheldon:
 - [Meeting With Dr. Sheldon - 02/04/2026](#)
- Priyanshu alerted me to the impending deadline for Libin Research Day abstract submission (February 6th at 11:59 P.M.), so I modified my Summer Student Research Day abstract, and sent it to Priyanshu to review
 - [Stretch_LibinResearchDayAbstract 20260204 AR.docx](#)
 - 8 words over the word count, but because of the short deadline, decided to send it to Priyanshu, anyway
 - Will send it to Dr. Sheldon for final review once the first stage of edits have been completed

02/05/2026

Notes:

- Priyanshu ended up not having any criticism on my Libin Research Day abstract, and just said that it looks “pretty good,” and that I should send it to Dr. Sheldon after trimming it down 250 words
 - I edited it down, removing 8 words, and then sent it to Dr. Sheldon for final review & approval
 - [Stretch_LibinResearchDayAbstract 20260205 AR.v2.docx](#)

02/09/2026

Notes:

- Dr. Sheldon has not provided me any feedback yet on my abstract; the deadline was recently extended from February 6th to February 16th, so there is more time for review. However, I prompted him to review my abstract sooner rather than later, so that there is more time for feedback & editing – I did this at about 9:00 A.M.
 - At midday (1:00 P.M.), Dr. Sheldon got back to me with comments on my abstract, and I accepted all of the changes that he suggested, making some small, additional modifications of my own; the abstract looks complete, and it appears ready for submission
 - [W Stretch_LibinResearchDayAbstract 20260209 AR.v3.docx](#)
 - Dr. Sheldon, knowing that I have already run SPSS to collect my statistical data, mentioned that he would like me to add some of that data to my abstract
- Dr. Garcia lecture at the beginning of class:
 - Described how we should break down our time, moving forward (over the next 3-ish weeks), before the School Science Fair and the closure of the Science Fair Portal
 - Dr. Garcia recommended, “uncharacteristically,” that we actually procrastinate the Science Fair Portal until after the School Science Fair is over
 - Being selected for the Calgary Regional Science Fair should be our top priority, rather than having the Science Fair Portal completed (which is not always reviewed, especially for Life Science projects)
 - Additionally, she stated that marks for ASP are not everything; we cannot create time, just as energy cannot be created. Therefore, with such a small amount of time available to us, we will need to make sacrifices in order to finish our projects to a high caliber. Even if it takes making a slightly less-detailed Logbook, or a worse Methodology Section paper (which I already have an extension for, until after Science Fair is over), then we need to do what needs to be done.
- Meeting With Mrs. Kale:
 - [Meeting With Mrs. Kale - 02/09/2026](#)

02/13/2026

Notes:



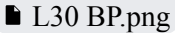





- I had a meeting this morning with Dr. Sheldon, detailing my aspirations for this weekend, with a primary focus on making my figures, completing & submitting a final copy of my Libin Research Day Abstract, and doing whatever else I can; I would like to make a rough draft of my poster and finish some extra background research, due to changes in my project (this may not be necessary), but both of these are lower-priority, as I have more time to finish them than the first two goals

- Meeting with Dr. Sheldon:
 - [Meeting With Dr. Sheldon - 02/13/2026](#)
- I ended up taking the rest of the day off after this meeting, with regards to ASP; I had other pending schoolwork to do, and I wanted to complete that before I began working on the goals listed above. I will have more time to work on my ASP later this Family Day Long Weekend (February 13-16)

02/15/2026







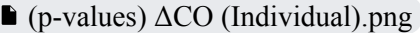

Notes:














- Revised abstract to include data, along with brushing up some of the introduction and methods for accuracy and (what I initially intended to be) brevity
 - [Stretch_LibinResearchDayAbstract 20260215 AR.v4.docx](#)
- I assumed a normal distribution for the data, so did not end up using the non-parametric data for results, instead siding for the parametric data
 - The parametric and non-parametric results were similar, suggesting few outlier data points that would otherwise impede the assumption of a Gaussian data distribution, so use of parametric data was justifiable
 - Therefore, I used means and standard deviations (parametric), rather than medians and interquartile ranges (non-parametric)
 - I also used Two-Sided p-values for significance, as assuming a one-way distribution of data variance (one-sided p-value) is not logical or acceptable for my project
- I ended up combining research question 2 with research question 1, as the primary components of blood pressure, cardiac output & systemic vascular resistance, can be described through the same statistical tests & data as blood pressure itself (systolic, diastolic, and mean arterial pressure)
 - Since the data for question 2 is insignificant, I will also likely exclude it from my research / CYSF project, as it feels somewhat reiterative to what I'm trying to describe with question 1, and has less-powerful implications for a broad population
- This abstract was over 100 words over the word limit (250), so I spent quite a bit of time cutting down words until I was just under the limit (249 words)
 - [Stretch_LibinResearchDayAbstract 20260215 AR.v5.docx](#)
 - I sent it to Dr. Sheldon for final review; although today is a Sunday, acknowledging the deadline for the abstract being today, Dr. Sheldon, during Friday's meeting, said that I could send him my abstract for review over the weekend, and that he would respond
 - Dr. Sheldon said that it looked good, and that it was ready for submission

- Using my dad's laptop, which has GraphPad Prism installed on it (per a paid subscription), I made figures for question 1 (All BP [SBP, DBP, MAP] for all stretches [L15, L30, U15, U30], and HR data, based on my SPSS statistical data
 -  L15 BP.png
 -  L15 ΔBP.png
 -  L30 BP.png
 -  L30 ΔBP.png
 -  U15 BP.png
 -  U15 ΔBP.png
 -  U30 BP.png
 -  U30 ΔBP.png
- However, I realized that I had accidentally forgotten to run descriptive statistics for U30 (stretch 4), which would have been a problem, had it not been caught sooner
- I will re-run the statistics for U30 tomorrow

02/16/2026

Notes:

- Re-ran U30 data in SPSS
 -  Stretch U30 Descriptives 20260215.pdf
- Created figures for all of the research questions (2 [technically], 3, & 4), with a primary emphasis on the blood pressure data (the most important data)
 - I added BP component (HR, SV, CO, SVR) figures for both individual and paired data, including figures with and without p-values
 - These helped to answer secondary sections of questions 3 & 4, along with question 2, although question 2 is no longer going to be specifically relevant to my project anymore
 - BP Components (Individual, No P-Values)
 -  ΔHR (Individual).png
 -  ΔCO (Individual).png
 -  ΔSV (Individual).png
 -  ΔSVR (Individual).png
 - BP Components (Individual, With P-Values)
 -  (p-values) ΔHR (Individual).png
 -  (p-values) ΔCO (Individual).png
 -  (p-values) ΔSV (Individual).png

-  (p-values) Δ SVR (Individual).png
- BP Components (Duration-Paired, With P-Values)
 -  Δ HR (Duration Paired, p-values).png
 -  Δ CO (Duration Paired, p-values).png
 -  Δ SV (Duration Paired, p-values).png
 -  Δ SVR (Duration Paired, p-values).png
- BP Components (Position-Paired, With P-Values)
 -  Δ HR (Position Paired, p-values).png
 -  Δ CO (Position Paired, p-values).png
 -  Δ SV (Position Paired, p-values).png
 -  Δ SVR (Position Paired, p-values).png
- I created BP figures, comparing the duration of stretch (L15 vs. L30 & U15 vs. U30) and position during stretch (L15 vs. U15 & L30 vs. U30), and added p-values for significance
 - These helped to answer the primary focuses of questions 3 & 4, respectively
 - Duration (BP):
 -  L15 vs. L30 Δ BP.png
 -  U15 vs. U30 Δ BP.png
 - Position (BP):
 -  L15 vs. U15 Δ BP.png
 -  L30 vs. U30 Δ BP.png

02/17/2026




Notes:

- Today, although I would have liked to make further progress on my ASP (due to impending deadlines), my Big Data Challenge (BDC) group, consisting of members from ASP class, needed my assistance in organizing the printing of our poster, and I needed to chase people down to submit their Media Release forms for the Western Canada High School Big Data Challenge (HSBDC) Symposium this Friday (February 20th)
 - I have a strong feeling that Thursday's ASP class time is going to have to be spent in a similar way, due to the fact that Thursday will be the day before the Western Canada HSBDC Symposium, and much preparation will be necessary for the 3-Minute Thesis & Poster Presentations that our group will have to do that day
 - Most of my ASP progress this week, which should primarily be focused on poster-creation / presentation-preparation, will likely have to be self-driven, during my own time, outside of class

- Meeting with Mrs. Kale:
 -  Meeting With Mrs. Kale - 02/17/2026



02/19/2026

Notes:

- As I predicted on Tuesday (February 17th), after my meeting with Dr. Sheldon at the beginning of the block, this ASP class was primarily spent preparing for the Western Canada HSBDC Symposium; yesterday, on February 18th, I had to personally print our group's poster (linked below), and since no one else took the responsibility upon themselves, I had to arrange the cutting of our poster, as well (so that it could nicely fit onto a trifold), speaking to the art teacher Mr. Sprau, and organizing a time (at lunch) to cut our poster using his paper cutter
 -   ESSAK BDC 2025-26 Poster.jpg
 - After school today, I also had to summarize the entirety of our incredibly long, complex BDC project (that I did a significant portion, and potentially even the plurality, of) into a cohesive 3-minute Thesis (presentation), and fully rehearse / memorize it, as we aren't allowed notes at the HSBDC Symposium; every other group member refused to present with me or put in the necessary time / effort to properly prepare for the Symposium, and I had to also practice answering difficult, niche questions about our project, in order to best be ready for the 3-minute question period from expert data scientists (that follows the 3-Minute Thesis presentation)
 - If the way that I'm writing this all out doesn't get the message across properly, I'll put it this way: I had to do insane amounts of work to get our group here, and now have to do insane amounts more with no support system or reasonable help, and it's incredibly frustrating. This means that my ASP progress is just going to be further delayed and, ironically, lack of ASP progress was one group member's reason for not wanting to do anything for our BDC project within the last week; yet, he thinks that I don't want / need my time to work on ASP, as well. It's all just frustrating.
- Meeting with Dr. Sheldon:
 -  Meeting With Dr. Sheldon - 02/19/2026

02/22/2026

Notes:

- After all of my trouble, our BDC group was able to win an award, and a fairly significant one at that:
 - “SM/Hony Lt Sanjeev Kumar Award for Resilient Innovation (1 award; \$1000)”
 - *“Awarded for demonstrating resilience to create implementable solutions with tangible social impact, prioritizing practical applicability over technical sophistication”*
- Yesterday, on February 21st, I attempted to create a project poster, using my figures and ASP project information & data, and utilizing our group’s BDC poster as a base for my design (my line of thinking was that it’s already the right size, at 48” by 36”); however, my data & results weren’t fitting in nicely, my methodology was messy, and it just didn’t work well at all, to the point that I’m not even bothering to show it here. It was a good experience to test out what works, but disappointing that this didn’t work properly, nonetheless.
 -  ESSAK BDC 2025-26 Poster.jpg
- Completed Google Slideshow for my Oral Presentation, in advance of my presentation on Monday
 -  (For Logbook) Arvind Raj - ASP Pre-Science-Fair Oral Presentation

02/23/2026

Notes:

- Day 1 of Oral Presentations:
 - Listened to Andi’s Oral Presentation
 - Andi attempted to create AI models to detect sarcasm in human speech
 - Model was given an 80:20 training-testing split, and Legendre coefficients, speech rate, and sarcasm type were analyzed
 - Accuracy of approximately 0.64 (64%) was recorded across most models, with one model recording accuracy of approximately 0.71 (71%)
 - Andi used type-sensitive models, which differentiates her research from the field
 - Andi used audio sarcasm from sitcoms (TV shows), so perceived sarcasm may have been exaggerated
 - Andi said that she removed artifact / outlier data points in her model training “by eye,” removing what she believed to be “noisy data”
 - Listened to Ronald’s Oral Presentation

- “Sticky Board Varroa Mite Detection and Counting Using Deep Learning and Data Augmentation”
 - According to Ronald’s presentation, honey is a \$7 billion dollar industry in Canada, yet about 1/3 of colonies died in 2024, a foremost cause being unchecked Varroa Mite outbreaks
 - One of the most important parts of managing Varroa mites is monitoring them, using sticky boards
 - Mites fall onto the boards, and beekeepers can determine just how bad the infestation is
 - Ronald’s research question is, “how can we develop accurate Varroa mite detection models with limited training data for automated counting?”
 - Augmentation will be experimented with, as well, due to this limited training data
 - Ronald used 64 images, taken via smartphone cameras, above stickyboards
 - Data augmentation pipeline: Random crop, scale symmetry, etc.
 - 70-10-20 dataset split
 - 70 training, 10 verifying, and 20 (percent) testing
 - If the model covers over 50% of the mites (or a mite), then it was considered to be a successful trial
 - Model accurately predicted 80% of the mites for all images
 - Ronald believes that a significant potential improvement would be to collect more data from beekeepers, across a larger geographical area, for greater data variability
- Delivered my Oral Presentation
 - It went alright; I knew that I was under low amounts of practice, and would likely not have had the best Oral Presentation, and it went fine
 - My main goal was for my Oral Presentation to be serviceable for now, and to be much better in time for the Science Fair
 - I’m fine to accept a slightly lower mark on this presentation, should it mean doing better on my official Webber Science Fair Oral Presentation
- Listened to Elise’s Oral Presentation
 - Elise attempted to utilize machine-learning modelling and GPS tracking to predict & track space debris, using data from the University of Calgary’s CASSIOPE satellite data
 - I took a lot lower a quantity of notes for this particular presentation because it was a live poster-presentation (rather than an online slideshow), and it felt a little bit uncouth to be constantly typing away on my laptop while Elise presented right next to me



02/27/2026

Notes:

- Day 3 of Oral Presentations (Missed Day 2 Due to Illness):
 - Listened to Shicheng's Oral Presentation
 - Shicheng's project was focused around examining the genetic makeup of *pasteurella multocida* bacteria, attempting to analyze the antiviral defense systems present in each isolate
 - Shicheng tried to isolate what genes, specifically, are responsible / conducive for antiviral defense systems
 - Shicheng found that AMR genes (antivirus systems) differed greatly depending on the bacterial strain analyzed, suggested variability in survivability / evolutionary history, per strain
 - Shicheng stated that, by studying the relatively understudied *P. multocida*, we can better understand how antibiotics impact strains of the bacteria
 - Listened to Richard's Oral Presentation
 - Richard evaluated the use of "Glenn Research Copper" as a heat exchange material in pressurized water nuclear reactors
 - Pure copper is infeasible to use in reactors as it currently stands; Glenn Research Copper is a chromium-niobium-copper alloy, hypothesized to improve the strength of the metal and facilitate the nuclear reactions
 - Alloy was created through a 3-hour centrifuge period at 100rpm
 - X-Ray diffraction was used to evaluate the grain size, Miller indices, and other factors that would aid in the evaluation of this alloy as a heat exchanger material
 - Neutrons were sent, like "bullets," at the GR Copper, in order to determine strength & nuclear reaction capabilities
 - Listened to Emma's Oral Presentation
 - Emma examined differences in case characteristics of child abuse, both with and without a domestic violence component
 - Emma used Chi-squared tests, standardized residuals, and Cramer's V to determine significance (p-values)
 - Emma concluded that child abuse cases (both with and without domestic violence involvement) involving biological fathers and other family members had higher rates of domestic violence than expected
 - No significant correlation was observed between primary abuse type & frequency of abuse and domestic violence


- Listened to Jessica's Oral Presentation
 - Jessica's project went over grey matter alterations associated with multiple sclerosis (MS)-induced cognitive difficulties
 - Multiple sclerosis is a biological disorder in which the immune system attacks the myelin sheath protecting the spinal-neural system – this significantly negatively impacts long-term cognitive function
 - Jessica sought to examine how gene expression in the grey matter varies between individuals diagnosed with MS and healthy controls, and what pathways are affected by these gene changes
 - Additionally, she sought to find out how altered genes are associated with neuronal communication and synaptic transmission, contributing to cognitive difficulties
 - Jessica found that MS grey matter is characterized by a decrease in gene expression of genes responsible for synaptic transmission and neuronal communication, with an increased expression in genes related to inflammation and extracellular matrix remodelling
 - Additionally, Jessica found that these pathway-level changes indicate a shift from healthy neuronal signaling toward immune-related and structural responses; there are many MS patients experiencing both neurodegeneration and inflammation within the cortex
- Listened to Lara's Oral Presentation
 - Lara mapped and evaluated the quality of intrauterine device (IUD) information accessed by adolescents
 - IUDs can be used to inhibit menstruation, decrease harm / inflammation caused by menstruation, and decrease menstrual blood loss
 - Lara sought to determine the degree of informational accuracy on menstruation, for adolescents, on commonly-accessed information-distribution sources (by adolescents)
 - Data from the two most-popular social media platforms for this information (TikTok and Instagram) were examined, engagement (likes / views) were analyzed, and “quality analysis” scores were gathered
 - Only about 50% of the content was educational, and little had an explicitly “positive” tone
 - This could harm public perception & knowledge about IUD usage
 - Analysis was hampered by a relatively small data set (sample size of 14), and this is a limitation for research that could be addressed in the future
- I designed and created my poster, based on my Google Slideshow (for Monday's official Webber Science Fair Oral Presentation); this time, rather than using the BDC poster as a basis

for my design, which was like trying to fit a square peg into a circular hole, I instead just created my own poster design (I like my posters colourful) that best fits my data, project, and the overall flow of my presentation:

-  AR Stretch Syncope Poster CYSF 20260227.jpg
-  AR Stretch Syncope Poster CYSF 20260227.pptx

03/01/2026

Notes:

- Today, I reformatted & remodelled my Research Proposal document to be relevant to the modern version of my project; although I left my Background Research section the same (for the most part), I ensured that my problem focused on the stretch maneuver in healthy individuals (pathology vs. physiology, as well), I updated my methodology to include the performance of relevant statistics & maneuver timings, along with referencing technologies used, and fixed my variables, final statement of significance, research questions, objectives, and hypotheses
 -  AR Research_Paper_CYSF_Complete_20260301.docx
 - This will help me to fill out the Problem, Method, and Research fields in the CYSF Portal, along with Citations (for the most part; I still have to include references for the images that I used, and I'm also including references that I used at any point in my project for my Citations section, even if some are now obsolete)
- I additionally practiced my Oral (Poster) Presentation for my project many times (over the span of about 3-4 hours), as the Webber Science Fair is tomorrow, and I need to ensure that everything is down pat before I have to present in front of judges
 - Although it took a couple of hours to get down the general flow and framework of the presentation (along with a relatively-set script for the beginning-section), I feel much more confident in presenting now than I did a few hours earlier





03/02/2026

Notes:

- Today, throughout my entire school day (9:00 A.M. to 3:00 P.M., approximately), I presented my poster and project to Science Fair judges (that Webber was able to gather). I feel that I did relatively well; I was somewhat sleep-deprived going into the day, and not feeling the best, either (I had a little bit of a frog in my throat as a results), but was able to present to all five judges in full (approximately 14-15 minutes per presentation), and all judges seemed to really like my presentation, and be genuinely interested in my project, which was very great to see
 - Although I am unsure as to how, specifically, I did, I feel as though I did relatively well, based on the reactions of the judges to my presentation, and how they seemed to be more genuinely curious, interested, and engaged in my project than looking to poke holes in anything
- Today, after I got home from the Webber Science Fair, I took a quick nap; then, understanding that I needed to continue to work on the CYSF Portal in order to have it done for March 4th (actually March 3rd, which is when Dr. Garcia said that it was due for us students, in order to be selected to attend the CYSF)
- I first made 4 data tables, one for demographics and 3 for each of the 3 primary research questions (hypotension, 15s vs. 30s, supine vs. standing); this was so that I could physically represent my data in the Data field of the CYSF Portal, while not having to use the figures that I already show on my poster (to avoid repetition)
 - [W AR CYSF Table 1 \(Demographics\) 20260302.docx](#)
 - [W AR CYSF Table 2 \(Hypotension\) 20260302.docx](#)
 - [W AR CYSF Table 3 \(15v30\) 20260302.docx](#)
 - [W AR CYSF Table 4 \(LvU\) 20260302.docx](#)
- I created a brief “Results” section, intended to be used with the data tables for the CYSF Portal’s Data field, which described key findings / takeaways, specifically using values that I added to the data tables
 - [W AR CYSF Stretch RESULTS 20260302.docx](#)
- I finally created a Conclusions section for the CYSF Portal. I wasn’t sure whether or not this was code for a Discussion section or supposed to be an actual Conclusion section, as there was no Discussion field in the portal; I incorporated some elements of a Discussion, but mostly focused on making my text mirror the key findings (conclusions) that can be made & summarized from my project, along with detailing the major implications of this work. I also included Limitations and Future Directions sections in my Conclusions section, basically just using the same Limitations & Future Directions that I listed on my poster (they are still accurate)
 - [W AR CYSF Stretch CONCLUSIONS 20260302.docx](#)

03/03/2026

Notes:

- Today, despite feeling unwell, I had to ensure that significant progress was still made toward completing the CYSF Portal (the Webber internal deadline for student submissions is today – technically tomorrow, March 4th, at 8:00 A.M., but that effectively means today, for all intents and purposes)
- Using (and copy-pasting) most of the documents that I created within the last two days, I filled out all written fields of the CYSF Portal (Problem, Method, Research, Data, Conclusion, & Citations, adding image-links as a part of my references), and wrote up an Acknowledgement section for all significant contributions to my project (primarily those who provided me with advice, information, or necessary documents / data)
- I am using the (cited) image of a heart beating, the same one that can be seen on the front of my logbook, as the Header Image on my CYSF Portal submission; I used my CYSF poster as my project image, and had a picture of myself taken (wearing a Libin Cardiovascular Institute quarter zip that I got over the summer); however, for the lattermost image, I did not heed the 4:3 ratio that was asked for, as I wasn't sure if a vertical or portrait orientation was being asked for, in this case (due to the fact that this is an individual photo of me). Hopefully this does not cause any issue; it said that this Participant Image was to be used for the “online awards ceremony,” and if that is actually the case, then it should be fine, as I have seen participant images of all sorts of shapes and sizes be used for CYSF online award shows in the past
 -  Heart Beating Logbook.png
 -  Arvind Image Libin Quarterzip.jpg
 -  AR Stretch Syncope Poster CYSF 20260227.jpg
- I recorded a video of my Oral Presentation, having to condense everything down into 10 minutes, although my full Oral Presentation is actually about 14-15 minutes long; the ending was a little bit sloppy, as I couldn't see how much time I had left and felt that I was running out (I actually was, nearing the 10 minute-mark). Overall, the video is fine in my eyes; although it has many imperfections, it is by far the best take that I had today, with most of my takes (likely well over 50) resulting in nothing significant. Since most of the mistakes are concentrated around the tail-end of the presentation, when most listeners should already understand my project and findings relatively well, it's not an enormous deal; however, it still is slightly frustrating, and I know that I can (and hopefully will) do better with more time on my hands, and not having to amend my presentation, at the CYSF
 -  AR Stretch Presentation Video 20260303.mp4
- Dr. Garcia informed me that not only had I made the Top 15 of the Senior High Science Fair presenters, but had actually placed 1st out of all of Senior High. This means that I am not only going to be attending the CYSF (April 9th to 11th), but also that the judges really liked my presentation, both stylistically and informationally (confirming my hopes)
 - This is great news, and I am incredibly happy to be given this opportunity, along with confirmation of the successes of my project
- I additionally completed today's Logbook entry, and submitted this copy of the Logbook (March 4th, 2026) to the Attachments section of the CYSF Portal

Background Research

1. Breakfast Blackouts – Case Report by Andrew Barritt and Bridget MacDonald, 2014

The authors present the case of a 16-year-old female presenting with episodes of collapse with loss of consciousness for 3-8 secs over the last 7 weeks.

No family history, taking no medications, no known health problems. Heart, respiratory exam, labs and ECG were normal.

Each episode occurred immediately following a specific yawn-stretch manoeuvre in the morning, with *both* having to occur together. The stretching involved flexion, then extension and abduction (rotating your arms from your sides upwards away from the midline), neck extension and arching backwards of the trunk (hyperlordosis). She would go pale and lose consciousness 3-5 secs later.

Only 13 other cases of stretch syncope have been reported in the literature. Adolescent males are mostly affected. The precise cause is not clear, but a combination of direct vertebral artery compression and reflex mechanisms are likely. It has been hypothesized that the hyperextended neck posture could compress the posterior neck tissues, negatively impacting the brain's blood supply via the vertebral arteries. However, it is physiologically unlikely that the resulting reduction in vertebrobasilar blood flow alone would be enough to result in passing out in a young person if their remaining intracranial blood vessels supplying the brain are normal.

The typical stretch, comprising back hyperextension, shoulder abduction and neck extension, includes a straining phase against a closed glottis, which is called a Valsalva manoeuvre. However, this may not adequately explain stretch syncope because a yawn involves both breathing in slowly and breathing out, and therefore may not produce a Valsalva manoeuvre. Indeed, some patients with stretch syncope can pass out without yawning and can prevent passing out if they resume forward neck flexion.

Pelekanos and colleagues found that the Valsalva manoeuvre alone was inadequate in their case series of stretch syncope patients to result in passing out, and that hyperextension of the head was also needed. Using Doppler ultrasound of the cranial blood vessels in 2 patients with stretch syncope, Sturzenegger found that only neck extension combined with outstretched arms resulted in reduced blood flow about 4 seconds later. Mazucca performed a similar study on a single male patient. With neck hyperextension and arm extension and abduction, Doppler showed reduced cerebral blood flow in the posterior cerebral arteries. Electroencephalogram (EEG) showed marked slowing with theta transitioning into delta waves, corresponding with loss of consciousness. Electrocardiogram (ECG) showed a small QRS complex during the stretch phase, consistent with a Valsalva manoeuvre. The patient did not have an exaggerated response to carotid sinus massage, suggesting that head turning did not

stimulate a hypersensitive carotid baroreceptor (which senses increased blood pressure).

Further study of 3 patients used EEG video telemetry, intra-arterial blood pressure measurement, and Doppler of the middle cerebral artery. Towards the end of the stretch, it was noted that heart rate increased, along with low blood pressure and cessation of diastolic blood flow in the middle cerebral artery. This suggests that stretch syncope is a unique type of reflex syncope involving increased heart rate and low blood pressure. In comparison, vasovagal syncope and carotid sinus hypersensitivity are marked by reduced heart rate and low blood pressure.

2. Transcranial Doppler and Angiographic Findings in Adolescent Stretch Syncope – Sturzenegger, 1995

This is a case series of 2 male adolescents with stretch syncope. Sturzenegger performed a physiologic study of these patients, involving various body positions and use of the Valsalva manoeuvre (straining against a closed glottis), while using transcranial Doppler of the posterior cerebral arteries and angiography to examine blood flow in real time. Maximal head extension and arm hyperabduction produced decreased posterior cerebral artery blood flow. Dynamic angiography showed extracranial compression of the craniocervical arteries in both patients.

Study conclusions:

Hyperextension of the head and neck is needed to induce stretch syncope.

Stretching alone without neck hyperextension is not enough to induce stretch syncope. This means that Valsalva's manoeuvre (which occurs when stretching) alone does not cause stretch syncope.

Decreased blood flow to the posterior cerebral circulation is an important contributing factor to stretch syncope.

3. Stretch Syncope: Reflex Vasodepressor Faints Easily Mistaken For Epilepsy – Sarrigiannis, 2010

Study of 3 male adolescents with stretch syncope. They were examined using continuous video EEG, transcranial Doppler of the middle cerebral artery (MCA), continuous blood pressure (BP) monitoring, and head-up tilt table testing. All episodes started with a period of stretching and breath holding, then impaired consciousness was seen 9-16 secs later often with asymmetric facial or upper limb jerks. The stretch was associated with increased heart rate and reduced BP, along with cessation of MCA

diastolic blood flow when the BP dropped. EEG showed generalized slow waves with loss of consciousness. Stretch syncope can be hard to distinguish from epilepsy due to some common features. These include the jerking movements, rhythmic EEG changes and rapid development of increased heart rate.

Insights into pathophysiology of stretch syncope:

Slow wave EEG abnormalities reflect generalized cerebral dysfunction. Stretch syncope is therefore a type of vasodepressor syncope, pointing away from it being caused by vertebrobasilar compression.

The delay between stretching and the occurrence of low BP and EEG changes suggests that a reflex mechanism is likely in stretch syncope.

A vasovagal manoeuvre is not enough to induce stretch syncope.

4. Stretch Syncope or Epileptic Seizure? – Routier, 2020

Stretch syncope is rare and can be misdiagnosed as focal seizures because of similar symptoms of clonic (repeated jerking) movements. A 7-year-old girl developed a 10-day history of falls with loss of consciousness occurring up to 10 times per day. Symptoms included altered muscle tone, impaired balance, loss of consciousness, and clonic upper limb movements. Extensive testing was unremarkable. Long-term video EEG monitoring identified that the triggering behaviour was stretching often accompanied by an altered breathing pattern consisting of prolonged inhalation followed by shorter exhalation (apneusis). This was followed by loss of consciousness and atonic fall. Pertinent test findings included slow waves on EEG prior to loss of consciousness, elevated heart rate and low BP. The QRS did not change on the ECG and there were no epileptiform discharges. Doppler of the cervical and cerebral arteries suggested reflex syncope.

5. Does a Therapy for Reflex Vasovagal Syncope Really Exist? – Romano, 2019

Syncope is temporary loss of consciousness due to lack of blood supply to the brain. It is brief with full recovery. The most common cause is reflex syncope, accounting for 21% of cases. This incorporates vasovagal syncope, situational syncope, carotid sinus syncope and non-classical forms.

Two main mechanisms cause reflex syncope. The first is vasodepression, where there is inadequate sympathetic vasoconstriction (adrenaline-driven constriction of the blood vessels). The second is increased cardioinhibition, where there is more

parasympathetic drive causing low heart rate or temporary cessation of the heart beating (asystole).

Reflex syncope usually occurs in the upright position. Common triggers include low blood pressure or blood loss, pain, stomach symptoms, strong emotions, coughing or sneezing, following exercise, or micturition. Reflex syncope is benign. There is no treatment with proven efficacy for recurrent syncope.

6. Situational Versus Vasovagal Syncope: One But Different? – Federowski, 2023

Reflex syncope is a temporary loss of consciousness. It is caused by a reflex by the nervous system causing sudden blood vessel dilatation and reduced heart rate (bradycardia). This results in a large drop in BP that deprives the cerebrum of adequate blood supply. There are 4 categories of reflex syncope: Vasovagal syncope (VVS), situational syncope, carotid sinus syndrome, and non-classical. Common triggers for VVS include orthostatic stress (adopting the erect posture but not adequately adapting to provide enough blood supply to the brain) or strong emotions (e.g. fear). Common triggers for situational syncope include swallowing, laughing, coughing, micturition, defecation, or bowel manipulation during endoscopy. Physiological experiments in patients suggest that the final reflex mechanism is very similar in both VVS and situational syncope, even though the triggers are different.

7. Self-Induced Stretch Syncope: An Unusual Non-Epileptic Paroxysmal Event. A Case report and Literature Mini-review – Mercante 2024

16 prior cases of stretch syncope have been described (12 males, age range 7-26). This paper presents the case of an 8-year-old girl presenting with stretch syncope. Episodes always occurred while awake, lasted 5-20 secs, and recovery was then rapid and complete. She was admitted to the hospital for investigations for possible narcolepsy (a sleep wake disturbance illness which includes the symptom of suddenly falling asleep in the daytime known as *cataplexy*). She underwent specialized testing for 4 days. All episodes were preceded by head tilting against the right shoulder, back and neck hyperextension, and sometimes breath holding and stretching of the upper limbs. She then lost postural tone and consciousness was impaired. EEG showed slow wave bursts. Heart rate increased and the ECG showed low amplitude QRS complexes (recall this reflects Valsalva manoeuvre – see source 1 above). Transcranial colour-coded duplex sonography (TCCS) showed reversal of blood flow in the right vertebral artery with the head turned to the left at 45 degrees and the patient felt faint. This reversed when the head was placed in a neutral position. This study suggests that reduced blood flow in the posterior circulation of the brain (as shown by the reversal of

blood flow in the vertebral artery on neck extension) likely contributed to the syncope in the patient (aka vertebrobasilar insufficiency). Furthermore, the local and generalized EEG slowing suggests reduced cerebral blood supply due to a drop in BP.

Pelekanos first described stretch syncope in 6 adolescents. He identified mechanical compression of the vertebral artery and Valsalva manoeuvre as causative factors. Another study of 2 patients found decreased blood flow in the posterior cerebral circulation during the typical position associated with stretch syncope, which supported Pelekanos's idea of vertebral artery compression. Similar findings were observed in another adolescent along with the effect of a Valsalva-like manoeuvre. A case report in 2 young girls with stretch syncope found vertebrobasilar insufficiency (inadequate blood flow in the posterior part of the brain's blood supply) due to extrinsic compression of the vertebral arteries. Another study of 4 patients noted a drop in BP followed by global cerebral dysfunction, suggestive of a vasodepressor response (caused by dilated blood vessels and reduced heart rate) rather than vertebrobasilar insufficiency. Adrenergic dysfunction during a Valsalva manoeuvre was also likely a contributor. A study in a 7-year-old girl with stretch syncope showed dynamic compression of the vertebral arteries induced a reflex syncope (blood vessel dilation and low heart rate), causing transient low blood flow to the brainstem.

8. Stretch Syncope in Adolescence – Pelekanos, 1990

This is the first description of 6 patients with stretch syncope. Cardiovascular responses during stretching were noted to be similar to those seen during a Valsalva manoeuvre, including increased heart rate during straining. This did not occur when the neck was straight.

The mechanism in common (vasodepressor) syncope is believed to be reduced vascular resistance without an adequate increase in cardiac output. However, this study suggests that the Valsalva manoeuvre is an important mechanism in stretch syncope.

The Valsalva manoeuvre is defined as trying to exhale against a closed glottis, causing increased pressure in the thorax. This then reduces venous return (blood return to the heart) and therefore cardiac output (including to the brain).

The authors acknowledge that Valsalva manoeuvre alone does not fully explain stretch syncope and the cause is likely multifactorial. For example, visual auras were common which are associated with posterior brain circulation impairment. Furthermore, both stretching and hyperextending are needed to induce loss of consciousness, not just a Valsalva manoeuvre.

9. Stretch Syncope in Humans: Evidence For Symptomatic Neural Reflex Hypotension Triggered by Stretching of Shoulder and Upper Back Muscles – Kosmopoulos, 2025

The authors performed an experiment regarding the stretching shoulder and upper back muscles, on hemodynamic alterations, in a population of both healthy controls and stretch syncope patients. The hemodynamics being examined were: heart rate (HR), systolic blood pressure (SBP, pressure of blood on the veins when the heart contracts, per beat), and mean arterial pressure (MAP, average pressure in a person's arteries, during one cardiac cycle [average of diastolic and systolic blood pressure, during a cardiac cycle]). They claim that stretch syncope is "often deemed to be of neural reflex origin," despite being of uncertain pathophysiology.

Stretch syncope is considered a very rare condition, even when compared to other syncope disorders like micturition syncope, cough syncope, swallow syncope, which are subsets of situational syncope, and especially when compared to vasovagal syncope, a broader type of syncope, also under the umbrella of reflex syncope. The authors state that previously proposed possible causes for stretch syncope, such as vertebral artery compression, carotid baroreceptor activation, and straining such as in the Valsalva response, are unsubstantiated. Muscle stretching has been reported to cause hypotension, particularly after exercise. While the reasoning is unknown, a plausible reason is the triggering of muscle mechanoreceptors during the activation of skeletal muscles.

Patients were instructed not to take cardioactive medications (including diuretics) for at least 5 half-lives before testing. Continuous HR was observed via ECG leads. Continuous BP was measured using a finger-monitor. The following tests were performed on all patients: active stand test, Valsalva manoeuvre, respiratory sinus arrhythmia, head-up tilt test, and active shoulder / upper back extension (shrugging) maneuver (while seated). The shrugging maneuver was performed for approximately 10-15 seconds – patients were not provided notice when the test began, to reduce central command bias, and patients were provided a demonstration of the maneuver directly before testing. A seated carotid sinus massage test was performed on stretch syncope patients only. It is generally a test performed on patients 50 years and older – it has been proposed that carotid sinus hypersensitivity could be a cause for stretch syncope, but none of the tests performed were positive. Stretch syncope patients reportedly did not experience "symptomatic hypotension" during Valsalva manoeuvre.

The patient population was composed of 9 stretch syncope patients, and 24 healthy controls, who presented with symptoms of lightheadedness or syncope (near or recurrent), unrelated to stretch. Of the 33 total people tested, 29 were female, and 4 were male – in the stretch syncope population, 8 were female, and 1 was male (sex). Healthy controls were age-matched to stretch syncope patients. Stretch led to nadir

SBP and MAP in both healthy controls and stretch syncope patients. Δ BP (drop, compared to baseline) was significantly greater in stretch patients than in healthy controls. Δ HR at BP nadir (increase) was about the same in both populations (11 vs. 12, healthy vs. stretch syncope). Time to BP nadir from stretch-onset and time to recovery from BP nadir were similar between both populations (healthy and stretch syncope).

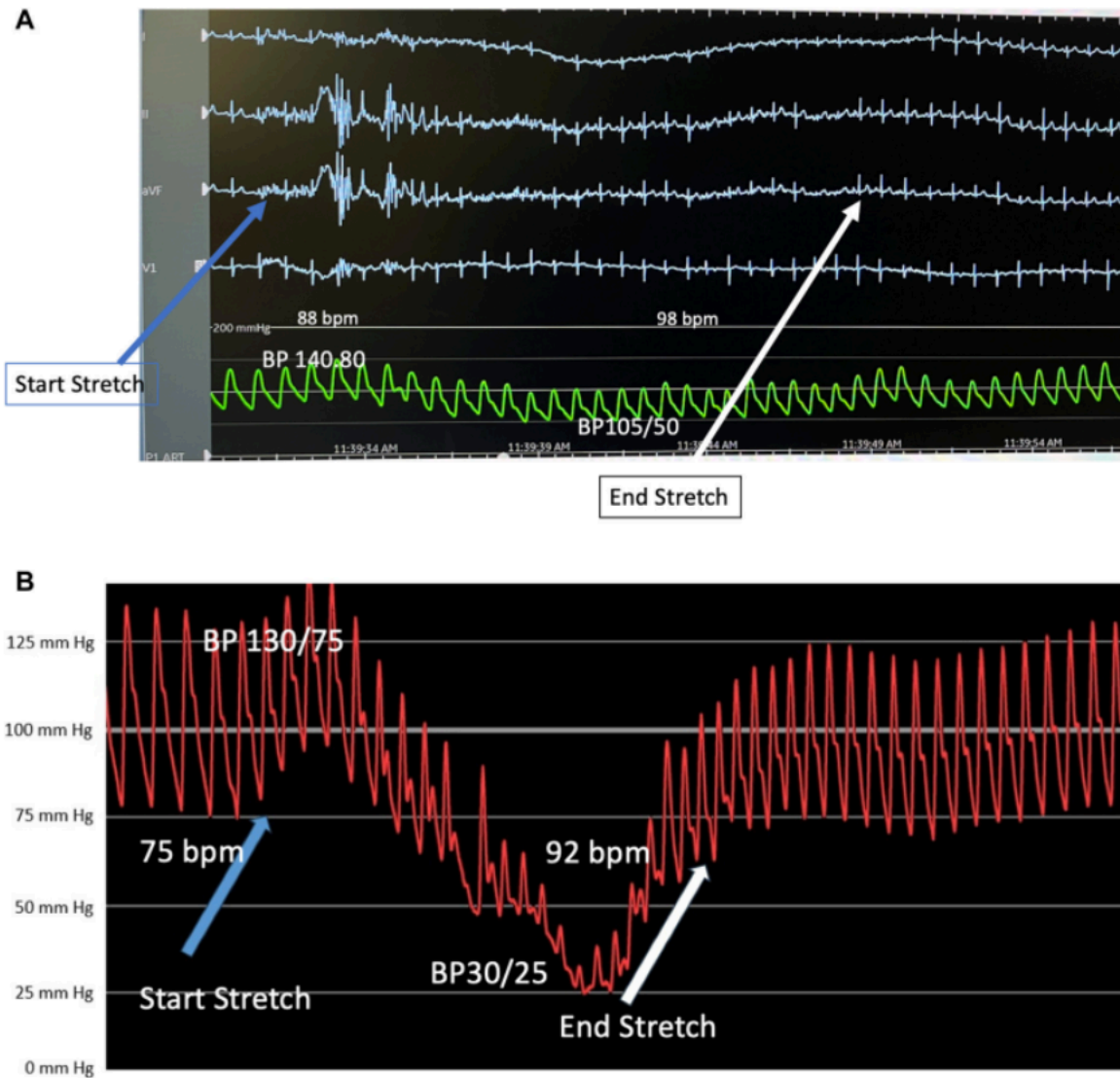
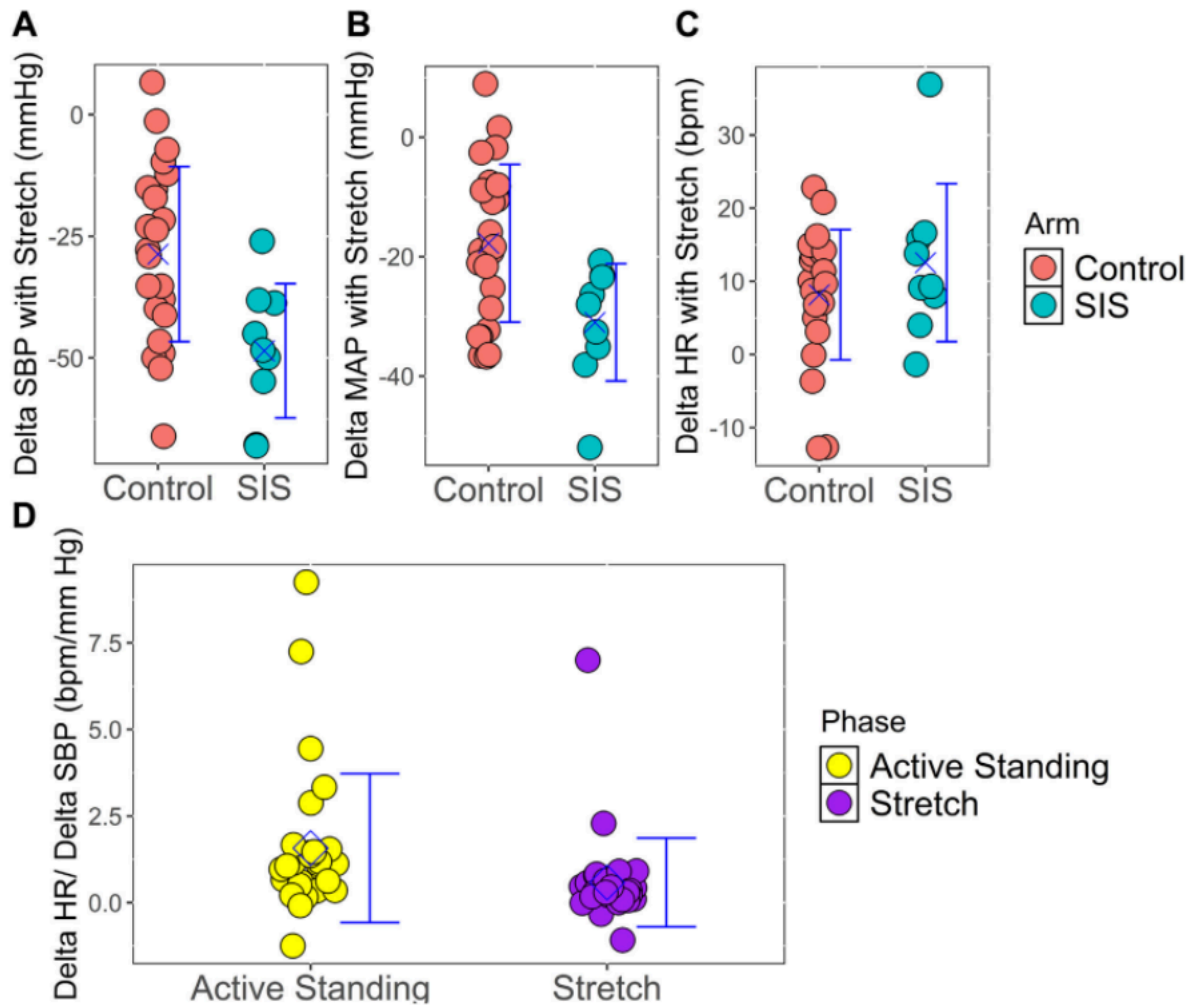


Figure A is a control patient, and Figure B is a patient with prior reported instances of stretch syncope onset.



Information provided in chart headings.

During stretching, 7/9 suspected stretch syncope patients (78%) either developed syncope (2 patients) or pre-syncope (5 patients). 5 patients in the control group experienced lightheadedness and a concomitant drop in BP, but none experienced syncope or pre-syncope.

Three main findings were derived from the paper:

1. Stretch syncope symptoms may be reproduced (in stretch syncope patients) when transient systemic hypotension is triggered through the hyperextension of upper back and shoulder muscles
2. The same stretching manoeuvre initiates transient hypotension in otherwise healthy control patients (lower degree than in stretch syncope patients)
3. Stretch syncope is likely the result of a neural reflex mechanism, supporting the concept that stretch syncope is a form of reflex syncope, and not a result of a previously proposed Valsalva response or vertebral artery constriction

The paper states that muscle mechanoreceptors are (likely) the trigger for stretch syncope, and that the combination of sympathetic withdrawal and / or parasympathetic activation limit the magnitude of HR compensation. It notes that the cause of stretch syncope is systemic hypotension, primarily due to reflex vasodepression caused by the stretching of large upper body shoulder and back muscles groups. Midodrine (5-10mg, 3x daily) was prescribed to 2 stretch syncope patients, with the goal of diminishing vasodepressor hypotension – it was unsuccessful, but the low dosage may have been the reason. A scopolamine patch was prescribed to 2 stretch syncope patients, but side effects limited its use, and the intervention was abandoned. The most effective intervention in decreasing the onset / symptoms of stretch syncope was the instruction to “avoid ‘stretching’” for stretch syncope patients, according to patient reports – quantitative assessment has not been undertaken. The paper further states that “treatment of [stretch syncope] is imperfect, and further study is needed.”

References / Citations

Research Proposal Citations

1-16

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Final (CYSF Portal) Citations

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Research Proposal

Research Proposal Rough Draft V1

Examining the Relationship Between Stretch-Induced Syncope and Hemodynamic Outcomes in Patients

1.1 Syncope (Reflex, Situational, Stretch-Induced)

Syncope is a transient (temporary) loss of consciousness due to an exaggerated hypotensive (low blood pressure) cardiac response after experiencing specific stimuli, or “triggers.” This hypotension leads to a critical lack of cerebral hypoperfusion (blood absorbed by the brain) (9, Kosmopoulos). The most common type of syncope is reflex syncope, accounting for 21% of cases (1 Romano). Reflex syncope is caused by a “reflex” response in the nervous system, resulting in a large drop in blood pressure (BP) that deprives the brain of adequate blood supply. Two main mechanisms cause reflex syncope: the first is vasodepression, where there is inadequate vasoconstriction (adrenaline-driven constriction of the blood vessels) of the sympathetic nervous system. The second is increased cardioinhibition, where there is more parasympathetic nervous system drive, causing low heart rate or temporary cessation of the heart beating (1, Romano).

There are 4 categories of reflex syncope: vasovagal syncope (VVS), situational syncope, carotid sinus syndrome, and non-classical. Situational syncope is an induction of syncope, triggered by a specific emotional, environmental, or physiologic event. There are numerous recorded triggers of situational syncope, such as coughing, belly laughs, medical instrumentation, and urination/defecation (2, Johansson).

Stretch-induced syncope (SIS) is a rare and poorly understood type of situational syncope, triggered by a “stretching” manoeuvre in affected patients. The direct cause of SIS has been subject to limited investigation. Proposed possible causes for SIS include vertebral artery compression, carotid baroreceptor activation, and straining such as in the Valsalva manoeuvre. These theories are unsubstantiated, however, as a direct result of the lack of literature surrounding SIS (9, Kosmopoulos). The most recent and comprehensive research on SIS, performed by Kosmopoulos et. al, has shown evidence that SIS is triggered by muscle mechanoreceptor activation with hyperextension in upper back and shoulder muscles. Further study of the basic reproducibility, symptomology, and treatment of SIS is required (9, Kosmopoulos). Below is a timeline of modern SIS research (1990 onwards).

1.4. Summary of Modern Stretch-Induced Syncope Research

Pelekanos et al. found that cardiovascular responses during neck hyperextension were similar to those seen during a Valsalva manoeuvre, including increased heart rate during straining. This did not occur when the neck was straight. However, it was clearly noted that other clinical

features that suggested additional mechanisms may be involved for induced syncope. For example, visual auras were common, which are associated with posterior brain circulation impairment (7, Pelekanos).

Sturzenegger et al. performed a physiologic study of 2 patients, with various stretched positions and use of the Valsalva manoeuvre, while using Transcranial Doppler of the posterior cerebral arteries and angiography to examine brain blood flow in real time. Maximal head extension and arm hyperabduction (arms stretched away from the midline) produced decreased posterior cerebral artery blood flow. Dynamic angiography showed extracranial compression of the craniocervical arteries in both patients, supporting direct vertebral artery compression during stretching. Sturzenegger concluded that hyperextension of the head *and* neck is needed to induce SIS, meaning that the Valsalva manoeuvre (which occurs when stretching, but not specifically the neck) alone does not cause SIS. Decreased blood flow to the posterior cerebral circulation must therefore be an important contributing factor to SIS (6, Sturzenegger).

Sarrigiannis et al. studied 3 male adolescents with SIS using continuous video electroencephalogram (EEG), transcranial Doppler of the middle cerebral artery (MCA), and continuous blood pressure (BP) monitoring. All episodes started with a period of stretching and breath holding, then impaired consciousness was seen 9-16 secs later. The stretch was associated with increase heart rate and reduced BP, along with cessation of MCA diastolic blood flow when the BP dropped. EEG showed generalized slow waves consistent with impaired consciousness. As slow wave EEG abnormalities reflect generalized cerebral dysfunction, it was concluded that the delay between stretching and the occurrence of low BP and EEG changes suggests that a reflex mechanism is likely in SIS. SIS is therefore a type of vasodepressor (reflex) syncope, pointing away from it being caused by vertebrobasilar compression alone (4, Sarrigiannis).

Mercante et. al studied an 8-year-old girl with SIS. Transcranial colour-coded duplex sonography (TCCS) showed reversal of blood flow in the right vertebral artery with the head turned to the left at 45 degrees and the patient felt faint. This reversed when the head was placed in a neutral position. This suggests that reduced blood flow in the posterior circulation of the brain (as shown by the reversal of blood flow in the vertebral artery on neck extension) likely contributed to the syncope in this patient (aka vertebrobasilar insufficiency). Furthermore, the local and generalized EEG slowing observed suggested reduced cerebral blood supply due to a drop in BP (5, Mercante). A study in a 7-year-old girl with SIS showed dynamic compression of the vertebral arteries induced a reflex syncope (blood vessel dilation and low heart rate), causing transient low blood flow to the brainstem (8, Routier – ref 3 in Mercante paper).

Kosmopoulos performed physiologic studies on 9 patients with SIS and 24 healthy controls. Subjects performed the active stand test, Valsalva manoeuvre, respiratory sinus arrhythmia, head-up tilt test, and active shoulder/upper back extension manoeuvre (shrug). They monitored heart rate (HR), systolic blood pressure (SBP, pressure of blood when the heart contracts), and mean arterial pressure (MAP, average pressure in a person's arteries, during one cardiac cycle [average of diastolic and systolic blood pressure, during a cardiac cycle]). During stretching, 7/9 suspected SIS patients (78%) either developed syncope (2 patients) or pre-syncope (5 patients). In the control group, 5 patients experienced light-headedness and a concomitant drop

in BP, but none experienced syncope or pre-syncope. They found that SIS symptoms may be reproduced (in SIS patients) when transient systemic hypotension is triggered through the hyperextension of upper back and shoulder muscles, relating to the activation of muscle mechanoreceptors in these areas. The stretching manoeuvre induces transient hypotension in otherwise healthy control patients. Induced hypotension is observed to be significantly greater in SIS patients than in healthy controls. It was concluded that SIS is likely the result of a neural reflex mechanism and is therefore not a result of a previously proposed Valsalva response or vertebral artery constriction (9, Kosmopoulos).

1.5 Relevance and Necessity of Research

We propose to advance the current limited understanding of the physiological mechanisms of SIS through use of a specialized stretch in a relatively large group of SIS patients and control subjects. We have the advantages of a large SIS sample size drawn from the Calgary Syncope Clinic, a globally recognized clinic specializing in the clinical care and treatment of patients with syncope, and a state-of-the-art modern human cardiovascular physiology laboratory. We will use modern equipment and in-depth studies to advance the field, including continuous monitoring of BP, HR, and MAP. These data will be used to calculate stroke volume, systemic vascular resistance, and cardiac output. These advanced hemodynamics have not been previously examined. This will contribute to determining the conditions surrounding SIS induction, symptoms of SIS, and basic reproducibility of SIS. Such knowledge will help us better inform SIS patients on how to manage and minimize the chance of future episodes.

2.1 Research Question

3.1 Manipulated Variable

3.2 Responding Variables

3.3 Controlled Variables

4.1 Hypothesis

5.1 Objectives

Short-term goals: To analyse data on HR, SBP, MAP, SV and calculated SVR and CO during performance of a stretch by a population of subjects with SIS. This will be compared statistically with similar data in healthy control subjects to form conclusions about the physiological mechanism(s) involved in SIS.

Long-term goals: To use the conclusions made about the physiological mechanisms involved in SIS to educate patients on how to minimize the onset of this phenomenon. Further, to use the findings gleaned from this study to guide future research in the subject.

Our findings may also be relevant to helping patients with other types of syncope, as they may share physiological mechanisms according to other studies.

6.1 Methodology

7.1 Significance

Studies of physiology in SIS note continued lack of clarity regarding the exact mechanism(s) involved, as they are limited by small sample size (it is a rare disorder) and use of less up to date physiology technology. Studies have found evidence for several possible physiological mechanisms, including the Valsalva manoeuvre, posterior circulation insufficiency (limiting blood supply to the brain), and/or a reflex mechanism (a triggered neurological reflex lowering HR and BP). Our ability to apply the most up to date physiological testing on a large cohort (as considered in this field) of patients with the rare disorder of SIS should positively impact the field by increasing our understanding of the exact physiological mechanisms that cause SIS. For example, ours will be the first study to calculate stroke volume, a measure of cardiac blood output to the brain, during syncope. This information will help answer the question of whether a reflex syncope mechanism occurs in SIS, and if so, if this is true for all the cases studied. Our study is important because it will significantly improve our understanding of the physiological mechanisms involved in SIS as we will have a large sample of patients to study (as considered in this field) using the most up to date physiology testing equipment. By clarifying the exact physiological mechanism(s) operating in SIS, we hope to better inform patients on ways to minimize the chance of experiencing future episodes.

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Research Proposal Rough Draft V2

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2.1 Research Questions

1. Is hypotension due to decreased venous return and stroke volume, or is it due to arterial vasodilation?
2. Is orthostatic stress necessary for induced hypotension?

3.1 Manipulated Variable

3.2 Responding Variables

3.3 Controlled Variable

3.4 Confounding Variables (May be None)

4.1 Hypotheses

1. Stretching reduces either stroke volume or systemic vascular resistance.
2. Orthostatic stress is necessary for the induced hypotension.

5.1 Objectives

Short-term goals: To analyse data on HR, SBP, MAP, and calculated stroke volume (SV), systemic vascular resistance (SVR), and cardiac output (CO) during performance of a stretch by a population of subjects with SIS. This will be compared statistically with similar data in healthy control subjects to form conclusions about the physiological mechanism(s) involved in SIS.

Long-term goals: To use the conclusions made about the physiological mechanisms involved in SIS to educate patients on how to minimize the onset of this phenomenon. Further, to use the findings gleaned from this study to guide future research in the subject.

Our findings may also be relevant to helping patients with other types of syncope, as they may share physiological mechanisms according to other studies.

6.1 Methodology

SIS patients will be eligible if they have: greater than or equal to one episode of SIS in the year preceding enrollment, are able to perform the stretch maneuver, and are greater than or equal to 18 years of age with informed written consent. Control subjects

will be eligible if they have: no history of syncope, are able to perform the stretch maneuver, and are greater than or equal to 18 years of age with informed written consent. All patients will be excluded if they have: (1) other causes of syncope, such as ventricular tachycardia, complete heart block, orthostatic hypotension, or hypersensitive carotid sinus syndrome, (2) an inability to give informed consent, (3) important valvular, coronary, myocardial or conduction abnormality or significant arrhythmia, (4) hypertrophic cardiomyopathy, (5) a permanent pacemaker, (6) a seizure disorder, (7) hypertension defined as greater than 160/90 mmHg, (8) pregnancy, (9) lactating women, (10) medications with known effects on BP, and (11) other factors which, in the investigator's opinion, would prevent the subject from completing the protocol.

Patients will be recruited locally from referrals to the University of Calgary Syncope Clinic of the Libin Cardiovascular Institute. We have no data on which to base sample size estimates. However, Kosmopoulos et al. (9.) reported a study population of 9 patients with SIS and 24 healthy controls. We propose sample sizes of up to 20 stretch syncope patients and 20 healthy control subjects.

Subjects will first perform a Valsalva maneuver, held for 10 seconds and following a maximal inspiration. They will then perform the stretch manoeuvre that consists of (1) upper back hyperextension, (2) shoulder abduction of the arm not wearing the fingertip blood pressure monitor, and (3) neck hyperextension. The position will be held for 15 seconds if possible. Movements will be performed twice 5 minutes apart while lying quietly and twice 5 minutes apart while secured comfortably on a head-up tilt test at an angle 70 degrees 5 minutes after assuming the upright position. The order will be randomized among subjects. Instrumentation will include conventional ECG electrodes to monitor continuous heart rhythm. BP will be monitored continuously using a Modelflow device, and prior to stretch will be calibrated with brachial cuff measurements. Advanced hemodynamic measurements (stroke volume, cardiac output, systemic vascular resistance) will be calculated with waveform-based Modelflow software. All hemodynamic data, including BP, HR, MAP, SV, CO, and SVR will be constantly logged and stored using the LabChart software. Directly proceeding each stretch, the participants will fill a validated questionnaire detailing their degree of presyncope, including syncope. MiniP, a MATLAB-based code, will be used to remotely access LabChart files and gain nadir, delta, and time-to hemodynamic data.

SPSS software will be used to determine the statistical significance of compiled data. Continuous variables will be presented as mean \pm SD when normally distributed, and median with 25th and 75th percentiles when non-normally distributed. Categorical variables will be expressed as numbers and percentages. The Mann-Whitney U test will be applied for comparison of continuous variables, and categorical variables will be compared by Pearson chi-square test and Fisher exact test, as appropriate. Secondary endpoints will include changes in estimated stroke volume (from the continuous BP

monitor), cardiac output, and systematic vascular resistance. These will all be compared between those who remain asymptomatic, experience presyncope, or experience syncope.

All of the above methodology has been approved by the Conjoint Health Research Ethics Board (CHREB).

7.1 Significance

Studies of physiology in SIS note continued lack of clarity regarding the exact mechanism(s) involved, as they are limited by small sample size (it is a rare disorder) and use of less up to date physiology technology. Studies have found evidence for several possible physiological mechanisms, including the Valsalva manoeuvre, posterior circulation insufficiency (limiting blood supply to the brain), and/or a reflex mechanism (a triggered neurological reflex lowering HR and BP). Our ability to apply the most up to date physiological testing on a large cohort (as considered in this field) of patients with the rare disorder of SIS should positively impact the field by increasing our understanding of the exact physiological mechanisms that cause SIS. For example, ours will be the first study to calculate stroke volume, a measure of cardiac blood output to the brain, during syncope. This information will help answer the question of whether a reflex syncope mechanism occurs in SIS, and if so, if this is true for all the cases studied. Our study is important because it will significantly improve our understanding of the physiological mechanisms involved in SIS as we will have a large sample of patients to study (as considered in this field) using the most up to date physiology testing equipment. By clarifying the exact physiological mechanism(s) operating in SIS, we hope to better inform patients on ways to minimize the chance of experiencing future episodes.

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Research Proposal Final Draft

Examining the Relationship Between Stretch-Induced Syncope and Hemodynamic Outcomes

Research Proposal

Applied Science Project

Arvind Raj

Dr. Robert S. Sheldon, Rashmin Hira, Priyanshu Giri

1.1 Syncope (Reflex, Situational, Stretch-Induced)

Syncope is a transient loss of consciousness due to global cerebral hypoperfusion, characterized by a rapid onset, short duration, and spontaneous complete recovery¹⁻². The most common type of syncope is reflex syncope, accounting for 21% of cases^{1,3}. Reflex syncope is caused by a “reflex” response in the nervous system, resulting in a large drop in blood pressure (BP) that deprives the brain of adequate blood supply^{2,4}. Two main mechanisms cause reflex syncope: the first is vasodepression, where there is inadequate vasoconstriction of the sympathetic nervous system. The second is increased cardioinhibition, where there is increased parasympathetic nervous system drive, causing low heart rate or temporary cessation of the heart beating^{1,5-6}.

There are 4 categories of reflex syncope: vasovagal syncope (VVS), situational syncope, carotid sinus syndrome, and non-classical¹⁻². Situational syncope is an induction of syncope, triggered by a specific emotional, environmental, or physiologic event^{4,7}. There are numerous recorded triggers of situational syncope, such as micturition, defecation, swallowing, coughing, and laughing^{4,7}.

Stretch-induced syncope (SIS) is a rare and poorly understood type of situational syncope, triggered by a “stretching” manoeuvre in affected patients⁸⁻⁹. The direct cause of SIS has been subject to limited investigation. Proposed possible causes for SIS include vertebral artery compression, carotid baroreceptor activation, and straining such as in the Valsalva manoeuvre^{8,10-11}. These theories are unsubstantiated, however, as a direct result of the lack of literature surrounding SIS¹⁰. The most recent and comprehensive research on SIS has shown evidence that SIS is triggered by muscle mechanoreceptor activation with hyperextension in upper back and shoulder muscles. Further study of the basic reproducibility, symptomology, and treatment of SIS is required¹⁰.

1.4. Summary of Modern Stretch-Induced Syncope Research

One study found that cardiovascular responses during neck hyperextension were similar to those seen during a Valsalva manoeuvre¹², including increased heart rate during straining. This did not occur when the neck was straight. However, it was clearly noted that other clinical features that suggested additional mechanisms may be involved

for induced syncope. For example, visual auras were common, which are associated with posterior brain circulation impairment⁸.

A physiologic study was performed on a population of 2 patients, with various stretched positions and use of the Valsalva manoeuvre, while using Transcranial Doppler of the posterior cerebral arteries and angiography to examine brain blood flow in real time. Maximal head extension and arm hyperabduction (arms stretched away from the midline) produced decreased posterior cerebral artery blood flow. Dynamic angiography showed extracranial compression of the craniocervical arteries in both patients, supporting direct vertebral artery compression during stretching. It was concluded that hyperextension of the head *and* neck is needed to induce SIS, meaning that the Valsalva manoeuvre (which occurs when stretching, but not specifically the neck) alone does not cause SIS. Decreased blood flow to the posterior cerebral circulation must therefore be an important contributing factor to SIS⁹.

3 male adolescents with SIS were studied using continuous video electroencephalogram (EEG), transcranial Doppler of the middle cerebral artery (MCA), and continuous BP monitoring. All episodes started with a period of stretching and breath holding, then impaired consciousness was seen 9-16 secs later. The stretch was associated with increase heart rate and reduced BP, along with cessation of MCA diastolic blood flow when the BP dropped. EEG showed generalized slow waves consistent with impaired consciousness. As slow wave EEG abnormalities reflect generalized cerebral dysfunction, it was concluded that the delay between stretching and the occurrence of low BP and EEG changes suggests that a reflex mechanism is likely in SIS. SIS is therefore a type of vasodepressor (reflex) syncope, pointing away from it being caused by vertebrobasilar compression alone¹³.

Transcranial colour-coded duplex sonography (TCCS) in an 8-year-old girl with SIS showed reversal of blood flow in the right vertebral artery with the head turned to the left at 45 degrees, and the patient felt faint. This reversed when the head was placed in a neutral position. This suggests that reduced blood flow in the posterior circulation of the brain (as shown by the reversal of blood flow in the vertebral artery on neck extension) likely contributed to the syncope in this patient (also known as vertebrobasilar insufficiency). Furthermore, the local and generalized EEG slowing observed suggested reduced cerebral blood supply due to a drop in BP¹⁴. A study in a 7-year-old girl with SIS showed dynamic compression of the vertebral arteries induced a reflex syncope (blood vessel dilation and low heart rate), causing a transient decrease in blood flow to the brainstem¹⁴⁻¹⁵.

Recently, physiologic studies were performed on 9 patients with SIS and 24 healthy controls. Subjects performed the active stand test, Valsalva manoeuvre, respiratory

sinus arrhythmia, head-up tilt test, and active shoulder/upper back extension manoeuvre (shrug). They monitored heart rate (HR), systolic blood pressure (SBP, pressure of blood when the heart contracts), and mean arterial pressure (MAP, average pressure in a person's arteries, during one cardiac cycle [average of diastolic and systolic blood pressure, during a cardiac cycle]). During stretching, 7/9 suspected SIS patients (78%) either developed syncope (2 patients) or pre-syncope (5 patients). In the control group, 5 patients experienced light-headedness and a concomitant drop in BP, but none experienced syncope or pre-syncope. They found that SIS symptoms may be reproduced (in SIS patients) when transient systemic hypotension is triggered through the hyperextension of upper back and shoulder muscles, relating to the activation of muscle mechanoreceptors in these areas. The stretching manoeuvre induces transient hypotension in otherwise healthy control patients. Induced hypotension is observed to be significantly greater in SIS patients than in healthy controls. It was concluded that SIS is likely the result of a neural reflex mechanism and is therefore not a result of a previously proposed Valsalva response or vertebral artery constriction¹⁰.

1.5 Relevance and Necessity of Research

Given the current limited understanding of the physiological mechanisms of SIS, this study proposes the use of a specialized stretch in a relatively large group of SIS patients and control subjects. This study has the advantage of a large SIS sample size drawn from the Calgary Syncope Clinic, a globally recognized clinic specializing in the clinical care and treatment of patients with syncope, and a state-of-the-art modern human cardiovascular physiology laboratory. This study will use modern equipment and in-depth studies to advance the field, including continuous monitoring of BP, HR, and MAP. These measurements will be used to calculate advanced hemodynamics such as stroke volume (SV), systemic vascular resistance (SVR), and cardiac output (CO), which have not been previously examined. This will contribute to determining the conditions surrounding SIS induction, symptoms of SIS, and basic reproducibility of SIS. Such knowledge will help us better inform SIS patients on how to manage and minimize the chance of future episodes.

2.1 Research Questions

1. Does upper extremity stretch induce a transient decrease in BP?
2. Is hypotension induced in stretch due to decreased venous return and SV, or is it due to arterial vasodilation?
3. Is orthostatic stress necessary for induced hypotension?

3.1 Hypotheses

1. Upper extremity stretch induces a transient decrease in blood pressure.

- a. This is corroborated by data collected by Kosmopoulos et al¹⁰ in their recent study.
2. Stretching reduces either stroke volume or systemic vascular resistance.
 - a. One of these two hemodynamic changes is necessary to cause significant cerebral hypoperfusion and syncope induction, according to Dr. Robert S. Sheldon, based on currently unpublished preliminary research.
3. Orthostatic stress is necessary for the induced hypotension.
 - a. Orthostatic stress is observed when participants are active standing rather than supine. Preliminary data analysis from currently unpublished patient files collected by Dr. Robert S. Sheldon demonstrated no sign of induced hypotension when participants were supine, but induced hypotension was observed when participants were active standing.

4.1 Objectives

Short-term goals: To analyse data on HR, SBP, MAP, and calculated stroke volume (SV), systemic vascular resistance (SVR), and cardiac output (CO) during performance of a stretch by a population of subjects with SIS. This will be compared statistically with similar data in healthy control subjects to form conclusions about the physiological mechanism(s) involved in SIS.

Long-term goals: To use the conclusions made about the physiological mechanisms involved in SIS to educate patients on how to minimize the onset of this phenomenon. Further, to use the findings gleaned from this study to guide future research in the subject.

Our findings may also be relevant to helping patients with other types of syncope, as they may share physiological mechanisms according to other studies.

5.1 Manipulated Variables

1. Upper body muscular stretch (before vs. after)
2. Body position during stretch (supine vs. standing)

5.2 Responding Variables

1. Blood pressure (SBP, MAP, DBP)
2. Heart rate (HR)
3. Stroke volume (SV)
4. Cardiac output (CO)
5. Systemic vascular resistance (SVR)

Every hemodynamic will be continuously measured before, during, and after stretch in healthy controls and SIS patients. These hemodynamic data will be used to directly

answer research questions. All research questions can be answered using collected hemodynamic data.

5.3 Controlled Variables

1. Medications will be held for 5 half-lives prior to studies.
2. Studies will be performed at least 2 hours after eating to minimize the effects of food and digestion on hemodynamic outcomes.
3. A standardized stretch procedure (outlined specifically under Methodology) will be performed by all study participants.

5.4 Confounding Variables

1. Sex (male vs. female)
2. Age (young vs. old)

6.1 Recruitment and Participant Eligibility

Patients will be recruited locally from referrals to the University of Calgary Syncope Clinic of the Libin Cardiovascular Institute.

SIS patients will be eligible if they have: greater than or equal to one episode of SIS in the year preceding enrollment, are able to perform the stretch maneuver, and are greater than or equal to 18 years of age with informed written consent. Control subjects will be eligible if they have: no history of syncope, are able to perform the stretch maneuver, and are greater than or equal to 18 years of age with informed written consent. All patients will be excluded if they have: (1) other causes of syncope, such as ventricular tachycardia, complete heart block, orthostatic hypotension, or hypersensitive carotid sinus syndrome, (2) an inability to give informed consent, (3) important valvular, coronary, myocardial or conduction abnormality or significant arrhythmia, (4) hypertrophic cardiomyopathy, (5) a permanent pacemaker, (6) a seizure disorder, (7) hypertension defined as greater than 160/90 mmHg, (8) pregnancy, (9) are lactating women, (10) medications with known effects on BP, and (11) other factors which, in the investigator's opinion, would prevent the subject from completing the protocol.

6.2 Instrumentation

Instrumentation will include conventional ECG electrodes to monitor continuous heart rhythm. BP will be monitored continuously beat-to-beat using a Finapres NOVA device. Prior to stretch, the beat-to-beat BP will be calibrated with brachial arm BP cuff measurements. Advanced hemodynamic measurements (SV, CO, SVR) will be calculated with waveform-based Modelflow software built into the Finapres NOVA. All hemodynamic data, including BP, HR, MAP, SV, CO, and SVR, will be digitally sampled at a frequency of at least 100 Hz using a PowerLab data acquisition system for later analysis with the LabChart software. Custom data analysis software written in a MATLAB programming environment (MiniP) will be used to analyze these LabChart files

to determine hemodynamics at the SBP nadir following stretch, the depth of the SBP drop, the peak HR following stretch, related hemodynamics, and the time-to SBP-nadir and time-to peak-HR data.

6.3 Testing Protocol

Subjects will first perform a Valsalva maneuver, held for 15 seconds and following a deep inspiration. This is a forced expiration against a closed glottis. This causes an initial drop in BP and tests the response and function of the autonomic nervous system. They will then perform the stretch manoeuvre that consists of (1) upper back hyperextension, (2) shoulder abduction of the arm not wearing the fingertip blood pressure monitor, and (3) neck hyperextension. The position will be held for 15 seconds if possible. Movements will be performed twice 5 minutes apart while lying quietly and twice 5 minutes apart while active standing, 10 minutes after assuming the standing position. The order will be randomized among subjects. Directly after each stretch, the participants will fill a validated questionnaire detailing their degree of presyncope, including syncope.

SPSS software will be used to determine the statistical significance of compiled data. Continuous variables will be presented as mean \pm SD when normally distributed, and median with 25th and 75th percentiles when non-normally distributed. Categorical variables will be expressed as numbers and percentages. The Mann-Whitney U test will be applied for comparison of continuous variables, and categorical variables will be compared by Pearson chi-square test and Fisher exact test, as appropriate. Secondary endpoints will include changes in estimated SV (from the continuous BP monitor), CO, and SVR. These will all be compared between those who remain asymptomatic, experience presyncope, or experience syncope. We have no data on which to base population sample size estimates. However, Kosmopoulos et al¹⁰ reported a study population of 9 patients with SIS and 24 healthy controls. We propose sample sizes of up to 20 stretch syncope patients and 20 healthy control subjects.

This methodology and project have been approved by the Calgary Conjoint Health Research Ethics Board.

7.1 Significance

Studies of physiology in SIS note continued lack of clarity regarding the exact mechanism(s) involved, as they are limited by small sample size (it is a rare disorder) and use of less up to date physiology technology¹⁰. Studies have found evidence for several possible physiological mechanisms, including the Valsalva manoeuvre, posterior cerebral artery circulation insufficiency (limiting blood supply to the brain), and/or a reflex mechanism (a triggered neurological reflex lowering HR and BP)⁸⁻¹⁰. This study's

ability to apply the most up to date physiological testing on a large cohort (as considered in this field) of patients with the rare disorder of SIS should positively impact the field by increasing our understanding of the exact physiological mechanisms behind SIS onset. This will be the first study to calculate advanced hemodynamics such as SV, CO, and SVR during stretch, providing new insight into the biomechanics of SIS and contributing to the overall field of study. Our study is important because it will significantly improve our understanding of the physiology involved in SIS with novel methodology and testing. This testing is supplemented by a large sample of patients to study (as considered in this field), using the most up to date physiology testing equipment. By clarifying the exact physiological mechanism(s) operating in SIS, we hope to better inform patients on ways to minimize the chance of experiencing future episodes and improve patients' quality of life.

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Introduction Section

Introduction Section Rough Draft (Incomplete References)

Examining the relationship between stretch-induced syncope and hemodynamic outcomes in subjects

Arvind Raj¹, Priyanshu Giri^{2,3}, Rashmin Hira, BSc^{2,3}, Dr. Robert S. Sheldon, PhD^{2,3}

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1.1 Syncope (Reflex, Situational, Stretch-Induced)

Syncope is a transient loss of consciousness due to global cerebral hypoperfusion, characterized by a rapid onset, short duration, and spontaneous complete recovery.¹⁻² The most common type of syncope is reflex syncope, accounting for 21% of cases.^{1,3} Reflex syncope is caused by a “reflex” response in the nervous system, resulting in a large drop in blood pressure (BP) that deprives the brain of adequate blood supply.^{2,4} Two main mechanisms cause reflex syncope: vasodepression, where there is inadequate vasoconstriction of the sympathetic nervous system, and increased cardioinhibition, where there is increased parasympathetic nervous system drive, causing low heart rate or temporary cessation of the heart beating.^{1,5-6}

There are 4 categories of reflex syncope: vasovagal syncope (VVS), situational syncope, carotid sinus syndrome, and non-classical.¹⁻² Situational syncope is an induction of syncope, triggered by a specific emotional, environmental, or physiologic event.^{4,7} There are numerous recorded triggers of situational syncope, such as micturition, defecation, swallowing, coughing, and laughing.^{4,7}

Stretch-induced syncope (SIS) is a rare and poorly understood type of situational syncope, triggered by a “stretching” manoeuvre in affected patients.⁸⁻⁹ The direct cause of SIS has been subject to limited investigation. Proposed possible causes for SIS include vertebral artery compression, carotid baroreceptor activation, and straining such as in the Valsalva manoeuvre.^{8,10-11} These theories are unsubstantiated, however, as a direct result of the lack of literature surrounding SIS.¹⁰ The most recent and comprehensive research on SIS has shown evidence that SIS is triggered by muscle mechanoreceptor activation with hyperextension in upper back and shoulder muscles. Further study of the basic reproducibility, symptomology, and treatment of SIS is required.¹⁰

1.2 Summary of Modern Stretch-Induced Syncope Research

One study found that cardiovascular responses during neck hyperextension were similar to those seen during a Valsalva manoeuvre,¹² including increased heart rate during straining. This did not occur when the neck was straight. However, it was clearly noted that other clinical features that suggested additional mechanisms may be involved for induced syncope. For example, visual auras were common, which are associated with posterior brain circulation impairment.⁸

A physiologic study was performed on a population of 2 patients, with various stretched positions and use of the Valsalva manoeuvre, while using Transcranial Doppler of the posterior cerebral arteries and angiography to examine brain blood flow in real time. Maximal head extension and arm hyperabduction (arms stretched away from the midline) produced decreased posterior cerebral artery blood flow.⁹ Dynamic angiography showed extracranial compression of the craniocervical arteries in both patients, supporting direct vertebral artery compression during stretching. It was concluded that hyperextension of the head *and* neck is needed to induce SIS, meaning that the Valsalva manoeuvre (which occurs when stretching, but not specifically the neck) alone does not cause SIS. Decreased blood flow to the posterior cerebral circulation must therefore be an important contributing factor to SIS.⁹

3 male adolescents with SIS were studied using continuous video electroencephalogram (EEG), measuring electrical signals in the brain through use of localized electrodes; transcranial Doppler of the middle cerebral artery (MCA), measuring cerebral blood flow; and continuous BP monitoring.¹³ All episodes started with a period of stretching and breath holding, then impaired consciousness was seen 9-16 secs later. The stretch was associated with increased heart rate and reduced BP, along with cessation of MCA diastolic blood flow when the BP dropped. EEG showed generalized slow waves consistent with impaired consciousness. As slow wave EEG abnormalities reflect generalized cerebral dysfunction, it was concluded that the delay between stretching and the occurrence of low BP and EEG changes suggests that a reflex mechanism is likely in SIS. SIS is therefore a type of vasodepressor (reflex) syncope, pointing away from it being caused by vertebrobasilar compression alone.¹³

Transcranial colour-coded duplex sonography (TCCS) in an 8-year-old girl with SIS showed reversal of blood flow in the right vertebral artery with the head turned to the left at 45 degrees, and the patient felt faint. This reversed when the head was placed in a neutral position.¹⁴ This suggests that reduced blood flow in the posterior circulation of the brain (as shown by the reversal of blood flow in the vertebral artery on neck extension) likely contributed to the syncope in this patient (also known as vertebrobasilar insufficiency). Furthermore, the local and generalized EEG slowing observed suggested reduced cerebral blood supply due to a drop in BP.¹⁴ A study in a 7-year-old girl with SIS showed dynamic compression of the vertebral arteries induced a reflex syncope (blood vessel dilation and low heart rate), causing a transient decrease in blood flow to the brainstem.¹⁴⁻¹⁵

Recently, physiologic studies were performed on 9 patients with SIS and 24 healthy controls. Subjects performed the active stand test, Valsalva manoeuvre, respiratory sinus arrhythmia, head-up tilt test, and active shoulder/upper back extension manoeuvre (shrug).¹⁰ Heart rate

(HR), systolic blood pressure (SBP, pressure of blood when the heart contracts), and mean arterial pressure (MAP, average pressure in a person's arteries, during one cardiac cycle [average of diastolic and systolic blood pressure, during a cardiac cycle]) were monitored. During stretching, 7/9 suspected SIS patients (78%) either developed syncope (2 patients) or pre-syncope (5 patients). In the control group, 5 patients experienced light-headedness and a concomitant drop in BP, but none experienced syncope or pre-syncope. They found that SIS symptoms may be reproduced (in SIS patients) when transient systemic hypotension is triggered through the hyperextension of upper back and shoulder muscles, relating to the activation of muscle mechanoreceptors in these areas. The stretching manoeuvre induces transient hypotension in otherwise healthy control patients. Induced hypotension is observed to be significantly greater in SIS patients than in healthy controls. It was concluded that SIS is likely the result of a neural reflex mechanism and is therefore not a result of a previously proposed Valsalva response or vertebral artery constriction.¹⁰

1.3 Study Introduction

Given the current limited understanding of the physiological mechanisms of SIS, this study aims to analyze the hemodynamic impact of the use of a specialized stretch in a relatively large population of SIS patients and healthy control subjects (up to 20 SIS, 20 healthy). This study has the advantage of a large SIS sample size drawn from the Calgary Syncope Clinic, a globally recognized clinic specializing in the clinical care and treatment of patients with syncope. This study will use modern equipment to continuously monitor BP and HR. These measurements will be used to calculate advanced hemodynamics such as stroke volume (SV), the amount of blood pumped out of the left ventricle during each systole (contraction of the heart); systemic vascular resistance (SVR), the opposition the body's blood vessels present to blood flow; and cardiac output (CO), the blood volume the heart pumps through the systemic circulation system, per minute. The correlation between advanced hemodynamics and SIS incidence has not been previously studied. A comprehensive understanding of the hemodynamic aspect of SIS will contribute to determining the broader conditions surrounding SIS induction, symptoms of SIS, and basic reproducibility of SIS. Such knowledge will help us better inform SIS patients on how to manage and minimize the chance of future episodes.

With this collected hemodynamic data and with the goal of providing a baseline understanding of the physiology of SIS, we seek to answer the following questions: (1) is hypotension induced during stretch due to decreased CO, or is it due to arterial vasodilation (decreased SVR)? (2) Is orthostatic stress (transient decrease in global blood flow immediately after standing from a supine position) necessary for induced hypotension? The first question will be addressed by comparing the delta value of CO with delta value SVR at the point of nadir (minimum) BP, during stretch. CO is compensatory to SVR; as one decreases, the other increases. Whether delta CO or SVR is most often negative at nadir BP in subjects will provide insight into a potentially direct relationship between either CO and SVR, and the induction of hypotension during stretch. The second question will be addressed by comparing the nadir BP values of stretching subjects while supine and while standing. Orthostatic stress is only achieved during active standing and is unattainable in a supine position. Supine and standing results will be compared and analyzed

using the SPSS statistical software. The degree of significance (calculated using the Pearson chi-square test) between mean standing and supine nadir BP values in subjects, will be used to determine whether orthostatic stress is necessary for induced hypotension. If statistical significance is found, orthostatic stress is likely unnecessary for induced hypotension; if statistical significance is not found, orthostatic stress is likely necessary for induced hypotension. Based on preliminary data analysis performed by Dr. Robert S. Sheldon on 5 currently unpublished healthy subject files, we hypothesize that hypotension is most often the result of transient arterial vasodilation, and that orthostatic stress is necessary for induced hypotension.

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Examining the relationship between stretch-induced syncope and hemodynamic outcomes in subjects

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1.1 Syncope (Reflex, Situational, Stretch-Induced)

Syncope is a transient loss of consciousness due to global cerebral hypoperfusion, characterized by a rapid onset, short duration, and spontaneous complete recovery.¹⁻² The most common type of syncope is reflex syncope, accounting for 21% of cases.^{1,3} Reflex syncope is caused by a “reflex” response in the nervous system, resulting in a large drop in blood pressure (BP) that deprives the brain of adequate blood supply.^{2,4} Two main mechanisms cause reflex syncope: vasodepression, where there is inadequate vasoconstriction of the sympathetic nervous system, and increased cardioinhibition, where there is increased parasympathetic nervous system drive, causing low heart rate or temporary cessation of the heart beating.^{1,5-6}

There are 4 categories of reflex syncope: vasovagal syncope (VVS), situational syncope, carotid sinus syndrome, and non-classical.¹⁻² Situational syncope is an induction of syncope, triggered by a specific emotional, environmental, or physiologic event.^{4,7} There are numerous recorded triggers of situational syncope, such as micturition, defecation, swallowing, coughing, and laughing.^{4,7}

Stretch-induced syncope (SIS) is a rare and poorly understood type of situational syncope, triggered by a “stretching” manoeuvre in affected patients.⁸⁻⁹ The direct cause of SIS has been subject to limited investigation. Proposed possible causes for SIS include vertebral artery compression, carotid baroreceptor activation, and straining such as in the Valsalva manoeuvre.^{8,10-11} These theories are unsubstantiated, however, as a direct result of the lack of literature surrounding SIS.¹⁰ The most recent and comprehensive research on SIS has shown evidence that SIS is triggered by muscle mechanoreceptor activation with hyperextension in upper back and shoulder muscles. Further study of the basic reproducibility, symptomology, and treatment of SIS is required.¹⁰

1.2 Summary of Modern Stretch-Induced Syncope Research

One study found that cardiovascular responses during neck hyperextension were similar to those seen during a Valsalva manoeuvre,¹² including increased heart rate during straining. This did not occur when the neck was straight. However, it was clearly noted that other clinical features that suggested additional mechanisms may be involved for induced syncope. For example, visual auras were common, which are associated with posterior brain circulation impairment.⁸

A physiologic study was performed on a population of 2 patients, with various stretched positions and use of the Valsalva manoeuvre, while using Transcranial Doppler of the posterior cerebral arteries and angiography to examine brain blood flow in real time. Maximal head extension and arm hyperabduction (arms stretched away from the midline) produced decreased posterior cerebral artery blood flow.⁹ Dynamic angiography showed extracranial compression of the craniocervical arteries in both patients, supporting direct vertebral artery compression during stretching. It was concluded that hyperextension of the head *and* neck is needed to induce SIS, meaning that the Valsalva manoeuvre (which occurs when stretching, but not specifically the neck) alone does not cause SIS. Decreased blood flow to the posterior cerebral circulation must therefore be an important contributing factor to SIS.⁹

3 male adolescents with SIS were studied using continuous video electroencephalogram (EEG), measuring electrical signals in the brain through use of localized electrodes; transcranial Doppler of the middle cerebral artery (MCA), measuring cerebral blood flow; and continuous BP monitoring.¹³ All episodes started with a period of stretching and breath holding, then impaired consciousness was seen 9-16 secs later. The stretch was associated with increased heart rate and reduced BP, along with cessation of MCA diastolic blood flow when the BP dropped. EEG showed generalized slow waves consistent with impaired consciousness. As slow wave EEG abnormalities reflect generalized cerebral dysfunction, it was concluded that the delay between stretching and the occurrence of low BP and EEG changes suggests that a reflex mechanism is likely in SIS. SIS is therefore a type of vasodepressor (reflex) syncope, pointing away from it being caused by vertebrobasilar compression alone.¹³

Transcranial colour-coded duplex sonography (TCCS) in an 8-year-old girl with SIS showed reversal of blood flow in the right vertebral artery with the head turned to the left at 45 degrees, and the patient felt faint. This reversed when the head was placed in a neutral position.¹⁴ This suggests that reduced blood flow in the posterior circulation of the brain (as shown by the reversal of blood flow in the vertebral artery on neck extension) likely contributed to the syncope in this patient (also known as vertebrobasilar insufficiency). Furthermore, the local and generalized EEG slowing observed suggested reduced cerebral blood supply due to a drop in BP.¹⁴ A study in a 7-year-old girl with SIS showed dynamic compression of the vertebral arteries induced a reflex syncope (blood vessel dilation and low heart rate), causing a transient decrease in blood flow to the brainstem.¹⁴⁻¹⁵

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