1 Results and Figures

1.1 Tool Comparison

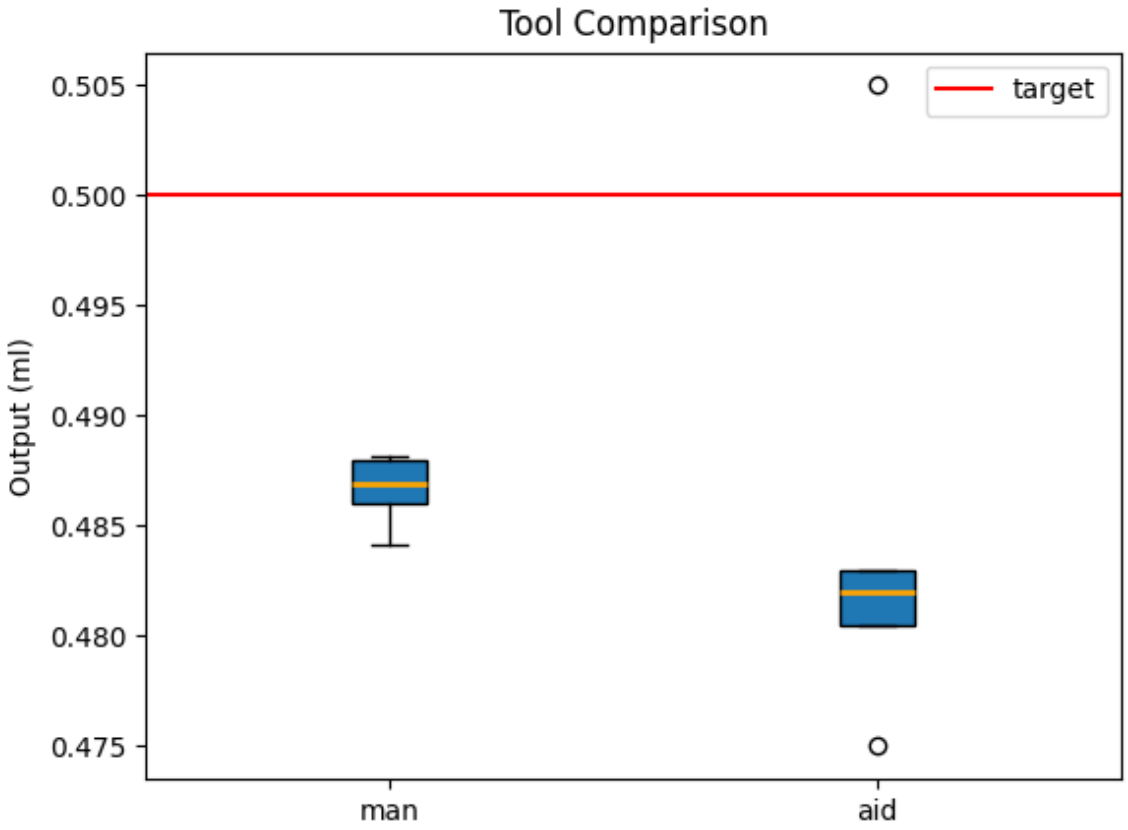

Figure 1: This experiment was performed on water. The pipette man has higher accuracy and precision compared to the pipette aid. Both tools undershoot fairly consistently.

From this figure we can conclude that the pipette man is more precise and accurate. However, the pipette man seems to be poorly calibrated throughout this entire lab. Despite having it at exactly .500 ml, the pipette always undershot by $.010 - .015$ml. The error for the pipette aid is due to a combination of the limits of the tool and the skill or lack thereof of the user.

1.2 Liquid Comparison

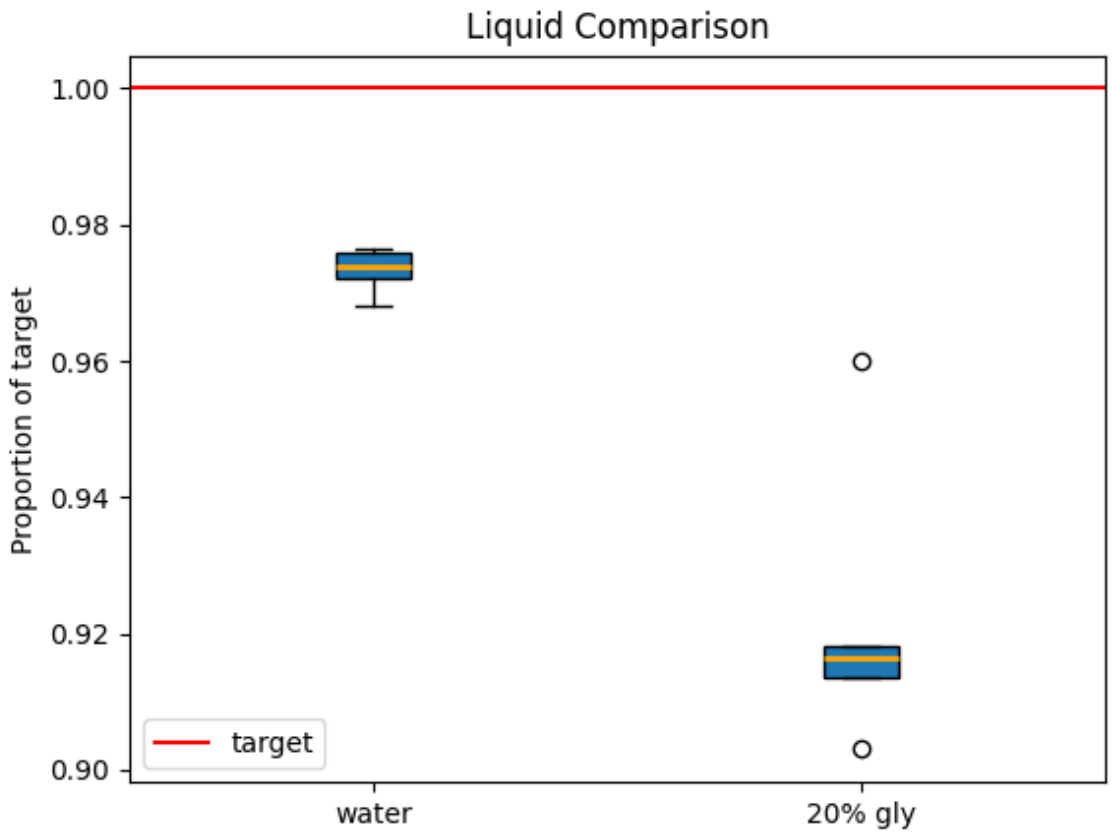

Figure 2: This experiment was performed was performed with the pipette man. Results have been normalized to their target weight, which was .5g for the water, and .526g for the 20% glycerol. We can see that the water had higher precision and higher accuracy.

From this we can conclude that the pipette man works much better with water. It has higher accuracy and precision compared to using the 20% glycerol solution. During the lab we noticed that it was difficult to get the entirety of the glycerol solution out of the pipette man, which is probably the reason for the severe undershooting.

1.3 Volume Comparison

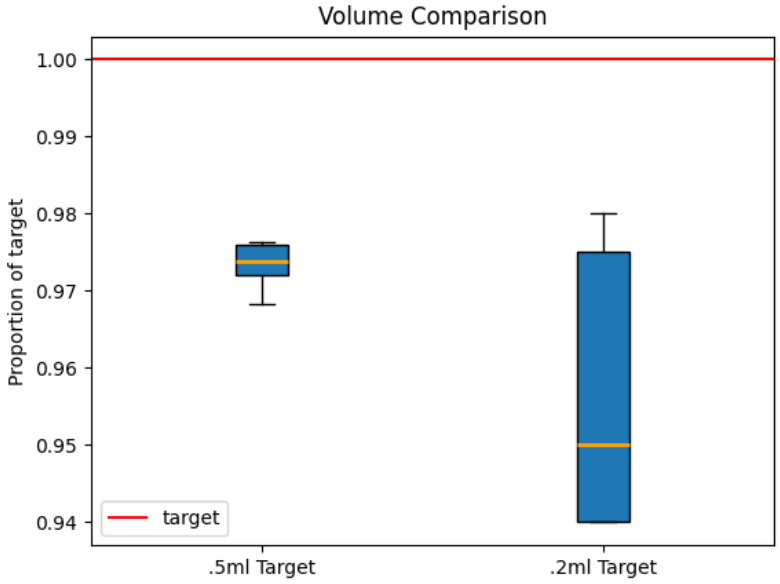

Figure 3: This experiment was performed on water using the pipette man. Results have been normalized to the proportion of the target. The .5ml target is more accurate and precise than the .2ml target.

From this figure we can conclude that using the pipette man on volumes higher in the range of the tool helps increase proportional percision and accuracy. From the figure below, we can see that in real values, the .2ml target seems to have better accuracy, but still worse precision. Perhaps shows that the underhsooting issue we see throughout this lab scales with volume.

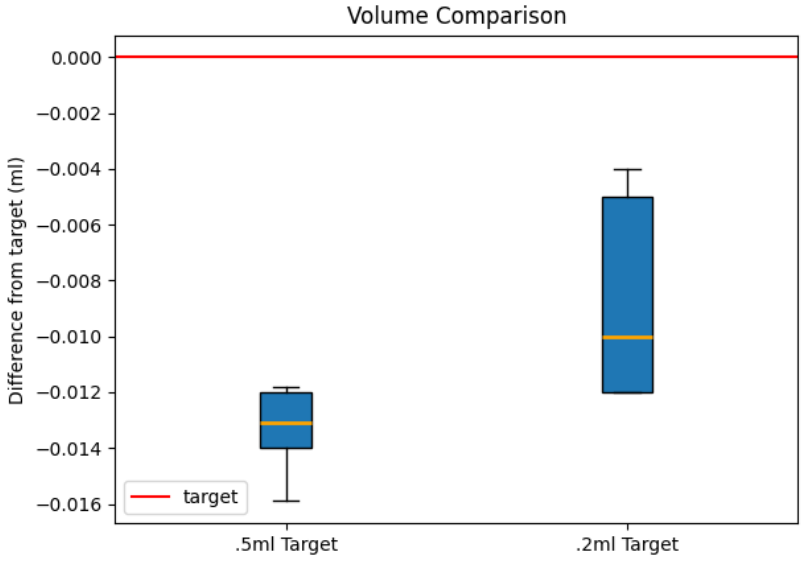

Figure 4: Same as figure 3, but with real difference from target in ml.

1.4 People Comparison

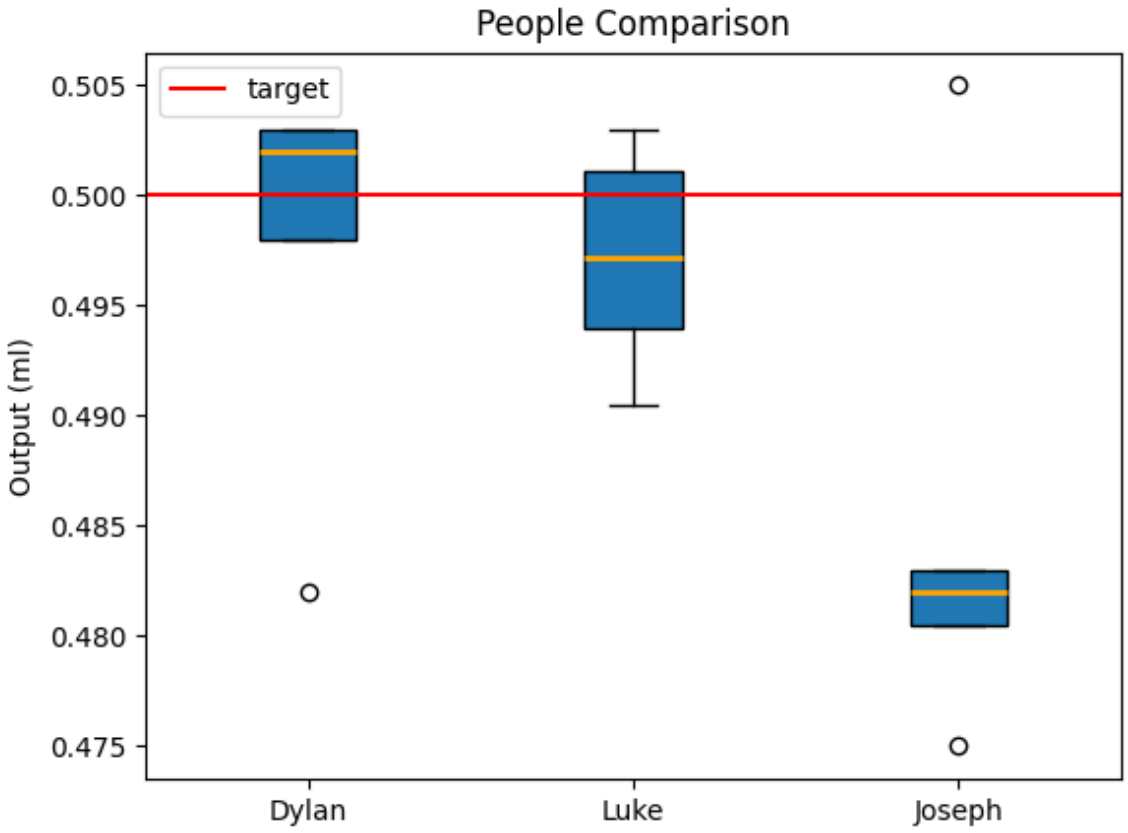

Figure 5: This experiment was performed on water with the pipette aid and a .5ml target. Dylan has the best accuracy and precision (except one outlier). Luke seems to have the second best while Joseph should work on his pipetting.

From this we can conclude that I am the best at pipetting within our group and Joseph is the worst. This means that I should be in charge of pipetting for future labs.

2 Experimental Issues

2.1 Human Error

Even in the sections which were not intented to measure the skill of our scientists, their skill was tested. A more skilled pipetter might have had significantly better results with both the pipette man and the pipette aid.

2.2 Material Error

As mentioned before, the pipette man significantly undershot for the entirety of the lab. Perhaps this issue could have been fixed via tuning the pipette man in some way or replacing it with a different one.

2.3 Evaporation

In the weigh boat, our liquid spread out significantly. This gave it large surface area making evaportation non-negligable. This caused the measurements to rapidly decrease while we were reading them, perhaps adding to the undershooting.

2.4 Splashing

Sometimes when depositing liquid into the weigh boat, it would splash onto the rear wall of the scale. This was especially prevalent when Joseph was pipetting. This would also cause a decrease in the read weight.

3 Data Table:

Data Record (submit a picture of this page for your Lab 1 Assignment):
Make sure to include clear labels for all data generated. Describe any observations you make during the execution of the lab.
Keep in mind that you'll want to record things that go wrong, things that you change in the protocol out of necessity, and any potential confounding factors. This will be useful information for analysis. Starting to do this now will help develop record-keeping habits that will benefit you when you work on more complex protocols.

Basic Measurement Protocol:

1. Add a weigh boat to the scale
2. (Zero) Tare the balance with weigh boat.
3. Dispense liquid of the target volume into the weigh boat.
4. Determine weight of liquid and record the result.
5. Remove weigh boat from the balance and dump the water into the 500 mL beaker to be used for waste.

Data Table: Unit: $g \cdot 10^{-2}$

water 0.5 mL

	1	2	3	4	5				
Man	49.41	49.69	49.80	49.10	49.82				
Aid	49.30	50.50	47.50	48.05	49.70				

0.5 mL man

	1	2	3	4	5				
water	49.41	49.64	49.86	49.66	49.82				
91%	52.00	53.60	53.31	52.90	52.00				

man water

	1	2	3	4	5				
0.5	49.41	49.69	49.86	49.66	49.82				
0.2	19.60	18.80	18.80	19.00	19.50				

aid water 0.5 mL

	1	2	3	4	5				
pylon	49.80	50.30	48.20	50.30	50.20				
Luke	49.72	49.40	50.11	49.05	50.30				
Joseph	48.30	50.50	47.50	48.05	49.70				

Observations:

- Constantly decreased in weight
  - evaporation while scale is zeroing
  - splashing outside

20% 91% 80% water

- Bubble in pipette man on 91%
- Pipette aid was difficult to measure
- zeroing of scale delayed

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