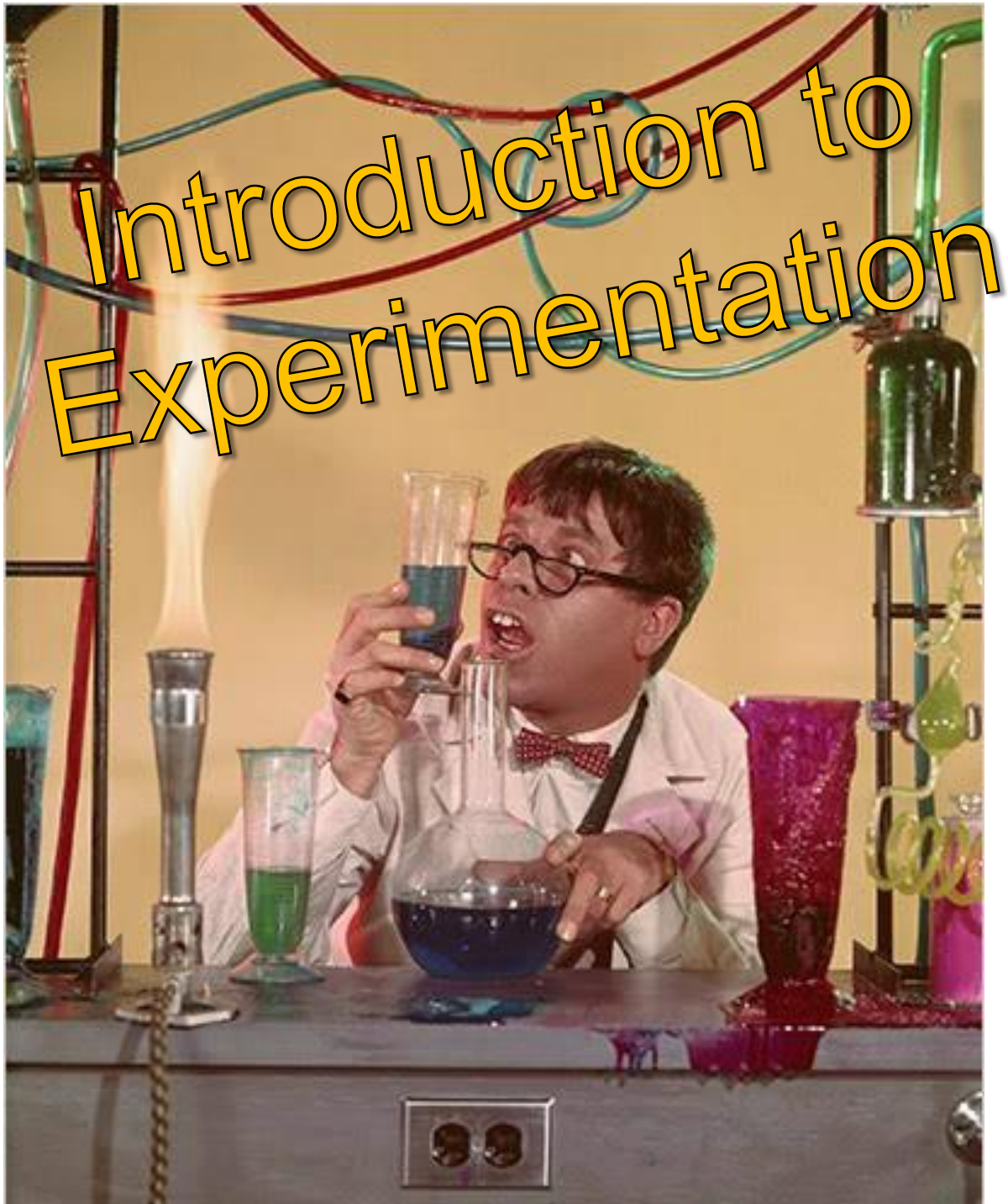
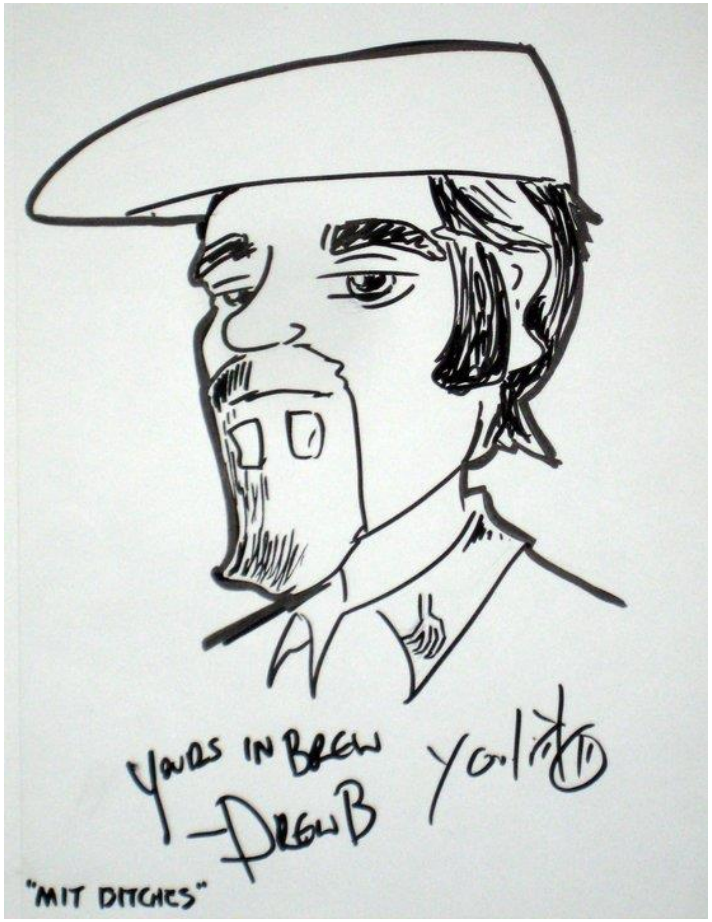

Introduction to
Experimentation

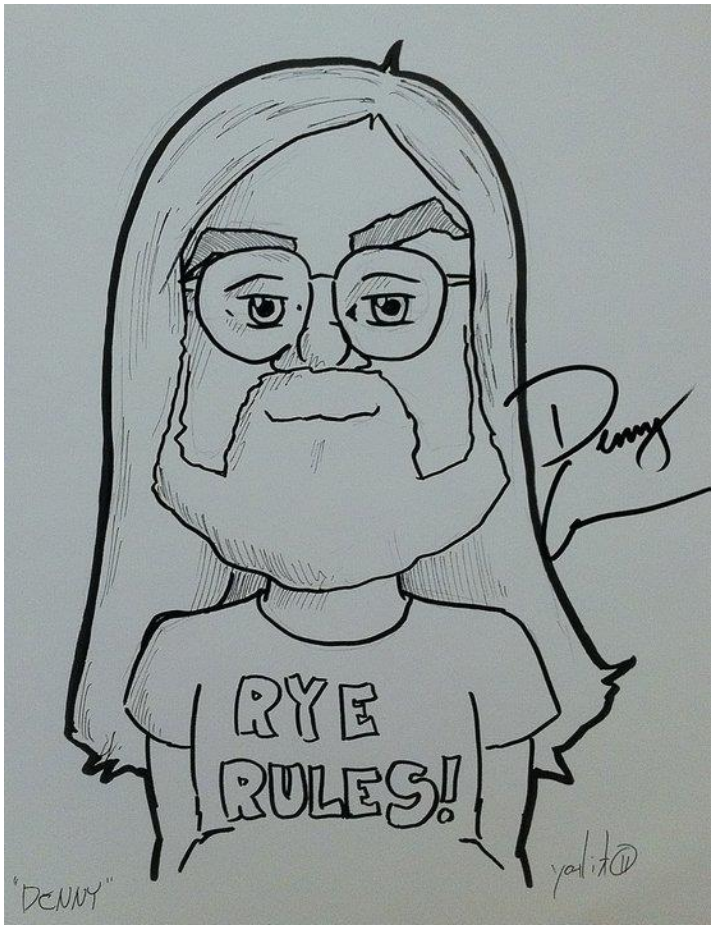
MAD SCIENCE IN THE PURSUIT OF GREAT BEER

EXPERIMENTAL HOMEBREWING

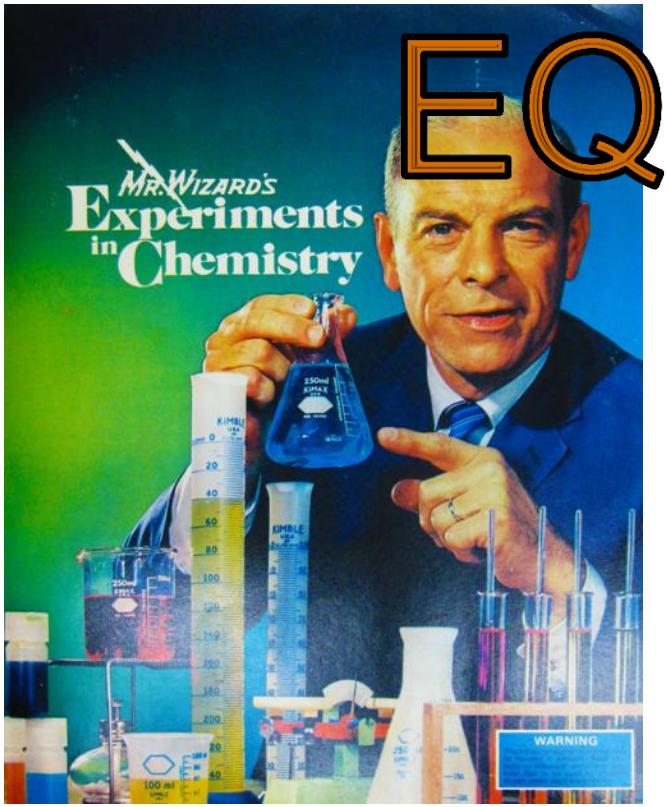
BY DREW BEECHUM
AND DENNY CONN

Mad Scientists





The Book EQUATION



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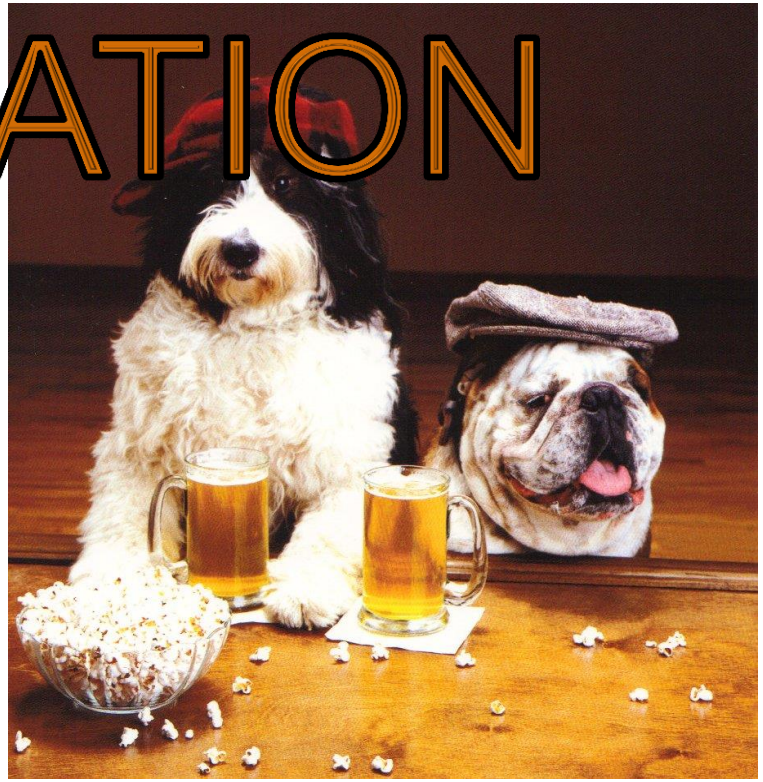

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Now, about those beers…

You have Sample A and Sample B

Think carefully…

Which do you prefer and why?

Shhhhh….

We'll ask you to vote at the end of the seminar

Why experiment?

- It's important that you know "How You Brew"
- It's important to know what actually works for homebrewers.
- It's important to know what's meaningful
- It's important to share with the community
- It's important to remember that it's Citizen Science

So you can…

- Make Better Beer
- With Less Effort and Wasted Time
- Have More Fun Brewing

What You need

- You'll probably have to have some duplicate equipment
- Another mash tun, more fermenters, airlocks, etc.
  - Or be really really clever about using what you already have
- Temperature control sized for multiple batches

What You need To DO

- Be repeatable
- Or figure out how to avoid replication
- Denny is awesome at repeatability
- Drew has never cared for the concept

Designing an Experiment

1. **Start with the question**
   "Do decoctions matter?"
2. **Then the hypothesis**
   "Decoctions do not create a noticeable sensory difference over an infusion mash."
3. **Then the Protocol**
   1. **Do two mashes – one decocted, one infused**
   2. **Ferment and package the same**
4. **Then the Evaluation…**

WARNING

- **This is a hell of a lot harder than you'd think**

ThinGs to consider carefully

- What do I care about?
- Crafting a Hypothesis is deceptively tricky
- Is my hypothesis falsifiable?
  - E.g. it's clear when you're wrong
- Remember – just because you get a positive result doesn't mean you're right!
  - It may be something else

Experiments you should do

Learning Ingredients

- Making teas and tinctures
- SMaSH Brewing
- Recipe reiteration changing only one thing at a time

mash experiments

- **Question:** Does step mashing affect our beer flavor in a perceivable manner?
- **Hypothesis**: Step mashing better controls the body and flavor of a beer compared to a single infusion mash.
- **Brewing Sessions Needed**: 2
- **Protocol**:
- **1.** Mash one batch of beer with a stepped mash, with rests of 145°F for 30 minutes and 158°F for 30 minutes.
- **2.** Mash a second batch at 152°F for 60 minutes.
- **3.** Ferment both batches the same way: Yeast strain, temperature, and fermenter geometry must be consistent.
- **Evaluation**: Perform the triangle and ranking tests, asking the tasters rank the samples in order of most to least body, head formation, and head retention. Ask them which they prefer and why.

mash experiments

- **Question**: How does changing the method of adding dark malts to the mash affect the flavor?
- **Hypothesis**: Adding dark malts into the mash early yields more acrid aromas and flavors than when they're added late to the mash. Both produce more aromas than the same amount of malt cold steeped and added to the boil.
- **Brewing Sessions Needed**: 2 or 3
- **Protocol**:
- **1.** Choose your favorite stout or porter recipe.
- **2.** Brew one batch with the dark malts (180°L or darker) mixed into the main mash.
- **3.** Brew again with the dark malt added to the mash just before lautering.
- **4.** Brew again with cold-steeped dark malt extract added to the boil for 10 minutes.
- **5.** Ferment and package identically.
- **Evaluation**: Do the triangle and ranking tests, asking your tasters about harshness and dark malt character.

Boil experiments

- **Question:** How does the bittering from FWH compare to the bittering from a 60-minute addition?
- **Hypothesis:** Some studies have shown that FWH actually produces about 10 percent more measureable IBUs than a 60-minute addition, but it tastes less bitter.
- **Brewing Sessions Needed:** 1 (split with two kettles)
- **Protocol:**
- **1.** Evenly split your wort into two kettles. Add your nominal 60-minute addition in one kettle as FWH before adding the wort. Note: We recommend Cascade hops for testing due to their noticeable but nondominating character.
- **2.** Steep the hops in the kettle while you sparge. Evenly split the sparge runoff between the 2 kettles.
- **3.** Bring both kettles to a boil.
- **4.** Add the same amount of the same hops as a 60-minute bittering charge to the other kettle after it comes to a boil. Boil both kettles for 60 minutes with no other hop additions.
- **5.** Cool, pitch, ferment, and package.
- **Evaluation:** Perform the triangle and ranking tests, asking tasters about the quality of bitterness (harsh, neutral, smooth) and hop flavor.

Fermentation experiments

- **Question:** Does the oxygen permeability of plastic buckets negatively affect beer left in contact with the plastic for a month in comparison to glass or steel fermenters?
- **Hypothesis:** For beers that have been actively fermenting and are still in contact with the yeast for a brief period (less than 4 weeks), the impact is negligible.
- **Brewing Sessions Needed:** 1
- **Protocol:**
- **1.** Split a batch of wort between a plastic fermenter and a glass or steel fermenter.
- **2.** Pitch equal amounts of yeast. They should have the same fermentation temperatures throughout fermentation.
- **3.** When fermentation is complete, keg or bottle both batches using the same techniques.
- **Evaluation:** Perform the triangle and ranking tests, asking tasters about off flavors and any differences between the beers.

Fermentation experiments

- **Question:** What is the effect of yeast pitch rate on ester production?
- **Hypothesis:** Pitching less yeast will result in fewer esters due to lack of acetyl-coA to create esters while it builds yeast cells.
- **Brewing Sessions Needed:** 1 (split batch)
- **Protocol:**
- **1.** Save the yeast slurry from a 5-gallon batch of beer in two sanitized containers. The easiest way to do this is to weigh the slurry so you have about 2⁄3 of the total in one container and 1⁄3 in the other.
- **2.** Produce a batch of wort and split it evenly between two fermenters. Pitch one container of slurry into each fermenter.
- **3** Ferment, package, and serve. Take periodic specific gravity readings to compare the fermentation profiles.
- **Evaluation:** Perform the triangle and ranking tests, asking the tasters about their perception of fruity esters.

packaging experiments

- **Question:** Does using different priming material affect the final characteristics of a bottled beer?
- **Hypothesis:** Priming a beer with DME will produce a finer bubble structure with improved head retention.
- **Brewing Sessions Needed:** 1
- **Protocol:**
- **1.** Brew and ferment the California Magnum Blonde (page 27).
- **2.** To one bottling bucket add 2.2 ounces of dextrose, boiled for 5 minutes in 1⁄2 cup of water. To the other bottling bucket add the 3.1 ounces of DME, boiled for 5 minutes with 1⁄2 cup of water.
- **3.** Fill each bucket with 2.5 gallons of wort, alternating the fill.
- **4.** Bottle into standard 12-ounce bottles.
- **5.** Age for at least 2 weeks at room temperature. Every 2 weeks thereafter, chill and open a bottle of each and evaluate.
- **Evaluation:** Perform the triangle and ranking tests, asking your tasters which beer has finer bubbles, better head retention, and smoother mouthfeel.

DON'T FOOL YOURSELF!

A Study of the Effect of Perceived Beer History on Reported Preferences by Sensory Panels with Different Levels of Training

J.E. Smythe and C.W. Bamforth

Journal of the Institute of Brewing
Vol. 8, No.1, 2002

The study indicates that the suggestion of a beer's history may well play a psychological role in the perception of the beer.

Merely suggesting a difference between histories causes some judges to perceive beers as different.

..as panel members are more highly trained, they appear to be less likely to declare a preference, effectively superseding the information they have been given

Regular vs. Accelerated Fermentation

Degree of Training	Rigorously Trained	Trained	Untrained
Country	Belgium	Finland	Ireland
Regular	7	5	5
Accelerated	1	4	5
no preference	6	3	2

All Malt vs Sugar Study

Degree of Training	Rigorously Trained	Trained	Untrained
Country	Belgium	Finland	Ireland
All Malt	6	7	6
Sugar	4	3	5
no preference	4	2	1

Tasting - Norwegian Style

Larsblog

http://www.garshol.priv.no/blog/187.html

We were then given a batch of three unidentified black beers, and told to write notes on them, then attempt to guess the beer styles. After tasting the three we were asked one by one to read our notes on the first one, all of which went along the lines of "roasty, caramel, maybe a bit neutral". The shock was considerable when we were told that it was, again, Ringnes Pils, this time with some black colouring added to it. Every single one of the 10 participants claimed to taste roastiness in the beer, and not one of the 10 so much as came near the idea that this might be a pilsener. An interesting example of the sense of taste being affected by visual signals.

The third beer was again described as having a pretty lasting brown head, being roasty, kind of neutral, maybe a bit sweet, and, by one person, as slightly estery. There was again considerable shock on being told that this was Erdinger Hefe-Weissbier (the pale variety) with dark colouring. We'd again been fooled by the colour into picking up an entirely imaginary roastiness, although the ester character is certainly correct.

I'm still surprised by this result. There was considerable beer tasting experience among the participants. There were three RateBeer users with approximately 8,000 ratings put together, one guy educated as a wine sommelier, two commercial microbrewers, and the rest were certainly not novices, either. And yet while the participants were able to recognize two beers simply by tasting them, they were also fooled into tasting something that was just not there. There is much research and anecdotal evidence indicating that people's sense of taste and aroma are strongly influenced by their expectations, so this shouldn't have come as a shock. But it did.

Wine Tasting – aka the Fraudulent Science

Another very interesting example, albeit with wine rather than beer, came from Frédéric Brochet in a 2001 experiment at the University of Bordeaux. He assembled a panel of fifty-four experienced wine tasters for evaluation of what they thought were four different wines. In the first test, they were given two glasses of wine, one white and one red. However, the red wine was actually the same white wine as was in the other glass with red food coloring. Nearly every taster described the red wine in terms ordinarily used to describe red wine, including words like jammy and crushed red fruit—terms that are seldom, if ever, used to describe white wines.

In another test he took two bottles of wine, one a *grand cru* and the other an ordinary *vin de table*, poured them out, and filled both bottles with a mid-level Bordeaux. Tasters then described exactly the same wine in almost completely opposite terms. The wine in the grand cru bottle was described as agreeable, woody, complex, balanced, and rounded, while the supposed vin de table was weak, short, light, flat, and faulty. Brochet's conclusion was that the perception of the wine was often more important than what was actually in the glass. Kind of makes you wonder about your own tasting skills and susceptibility to labels, doesn't it?

Money and Impact of Pleasure

Avenue Vine
Jan. 14, 2008

A study has found that people who pay more for a product do enjoy it more. The researchers discovered that people given two identical red wines to drink said they got much more pleasure from the one they were told had cost more. Brain scans confirmed that their pleasure centres were activated far more by the higher-priced wine. The findings could help to explain why rich diners are often willing to pay thousands of pounds for a bottle of fine wine. It seems much of the real pleasure is generated by the high price paid rather than by the quality of the vintage.

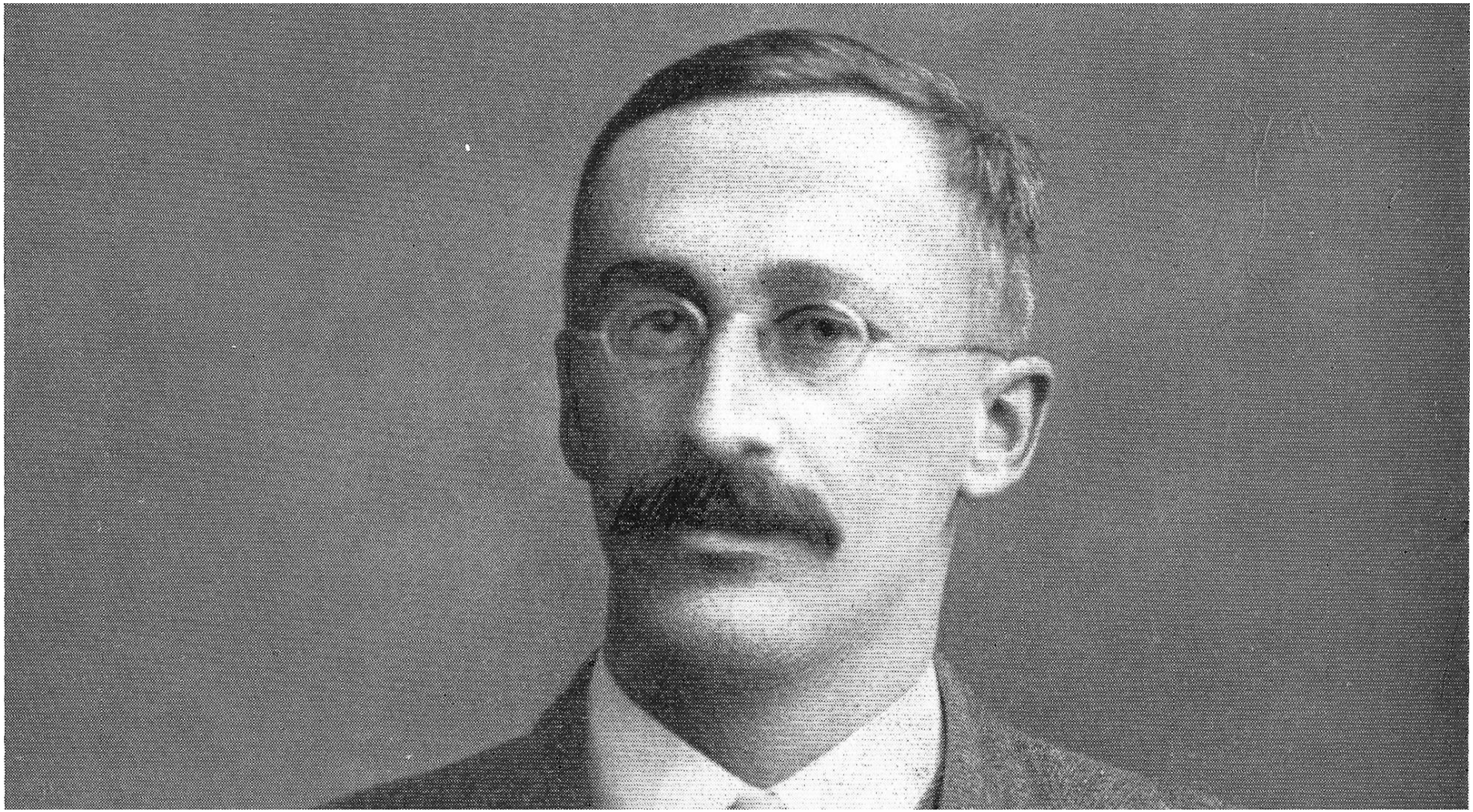
The researchers observed changes in a part of the brain known as the medial orbito-frontal cortex, which plays a central role in many types of pleasure. They found that the cortex became more activated by the“expensive” wines than by the cheaper ones. This, said Rangel, showed that the increase in pleasure was real, even though the products were identical.

Triangle Test

Triangle Tasting: - The Gateway to Validity

- Cornerstone of Beer Evaluation
- Difference Test – Which one of these things is not like the other?
- Determines if a difference exists at all
- Also a test of panelist quality
- Doesn’t work for vastly different beers, like a pilsner and a stout
- Looking for slight differences
- Can be turned into a duo-trio test – one sample is the reference, others are compared to it

A Very Important Student



Student T Test

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{1}{2}} \cdot (s_{x_1}^2 + s_{x_2}^2) \cdot \sqrt{\frac{2}{n}}}$$

Student Example One
t=0.44

Beer 1	Beer 2
35	20
34	21
38	22
23	33
42	28

Student Example Two
t=0.14

Beer 1	Beer 2
34	22
33	23
37	24
22	35
41	30

Hey Kids! It's Science Time!

Time for a

Demonstration!

And now to test the mettle of a few "blind" judges

Blinded Me With Science

- Say hi to Marshall – he's our blinding element
  - Brulosophy.com – Home of the exBEERiment
- What is a blind?
  - Protects the question "Hey does this beer taste <blanker> than this other one?"
- Single blind – We serve the beers
  - We know the experiment
  - We can influence
- Double blind
  - We know
  - Marshall doesn't
  - We keep our mouths shut and watch the data come in
  - This is where spouses, partners, SO's come in handy!

The Experiment

- Shhh! – Don't let the Panel know!
- Question: Does a beer brewed to a higher gravity and "watered down" taste the same as a beer that had no water added?

Why Would You Do that

- Turns out Fermenters are cheaper than new brewing gear
- Make more beer in the same amount of time
- Used by the big boys
- And for this beer, I was brewing with a PicoBrew Zymatic which is limited to 2.5 G of wort.
- So, brew strong, water down – make more beer.

Your turn

- You've had two samples today – A & B
- Think real quick – which do you prefer?
- Why?
- Show of hands!
- A?
- B?
- Neither?

Experimental Reveal

- Sample A – Magnum Blonde diluted to normal strength
- Sample B – Magnum Blonde diluted to normal strength
- In fact, both samples are the same beer!
- (Two batches mixed together in the kegs after fermentation)

Wha?!?!?

- If choose one of the samples, you've probably fallen prey to the "false dilemma"
- We set you up
  - Previous Experiment "Beer A vs Beer B"
  - These beers we've referred to as "Sample A vs Sample B"
  - Real differences
  - Using the same language and same setup set an expectation in the crowd about the choices
  - Everyone forgets that a third choice exists – "Same/No Difference"

Questions?
Ask!

Find us at:
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