



Women in Science and Engineering: What the Research *Really* Says

A panel discussion co-sponsored by WISELI and the Science Alliance.

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Biotechnology Center Auditorium, University of Wisconsin – Madison

“Are There Gender Differences in Brain Structure?”

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Good evening. How are we doing? Elect a spokesperson. Answer individually. My name is Paul Whalen I do structural and functional brain imaging over in the Waisman Center. What that means is I can get pictures of the structure of the brain of my subjects. And then I can let them continue to lie there in the dark and enjoy that immensely and show them pictures and things and try to provoke what ever it is I want to provoke. And I can get [images of the] functioning of the brain. What I really study is blood flow but what we think is that's related to neural activity. That's a huge assumption but it's the assumption my entire career rests upon.

So today I mostly have to get your expectations in the right place. I don't study gender. I am a gender. I won't reveal which one. But that's about the expertise I bring to this. What I can tell you about is the fact that when I hang up a flier on campus and people respond to it, they end up being of two genders and I am faced with that problem. How I'm going

to deal with that, what I'm going to do with my data, how I'm going to react when other people publish studies telling me about gender effects. People rejecting my grants because I'm not talking about gender effects when in fact I'm not sure if I believe the ones I've read about. So why do I have to, why am I pushed to and forced to have this in my own work? Really, I think what you're going to get out of this talk ... is how to critically evaluate some of the brain imaging findings that you see. I mean, I think that's the best thing you're going to get from me. I'm not going to have gobs of information for you on what the gender differences out there are. And I think when we get to the end of it you'll see why I'm not willing to tell you about any one of them, because they all rest upon a lot of these assumptions.

So there's our spark plug as we heard about and those were the three hypotheses. And I actually hadn't heard or read any of this and I had heard the headlines that there were innate brain differences between men and women. And that's what was the basis of a lot of this. Then I went to the writing and in fact you can't find that statement, but you can find this one and I think it's reasonable to assume that if one makes a statement like this, that there is a different availability of aptitude, you would have to suggest it's coming from somewhere. And if you spent the rest of the talk talking about gender, then people are going to make assumptions that that's what you're referring [to].

So, let's look at the people who have tried to assess that problem. Why am I here if I don't study this for a living? Well, I don't train men and women I train students. And as Jo just brought up, we're talking about this. Everyone is talking about this. And I don't

have a lot of answers for what I say to someone like Jonathan [points to slide of students], who thought Caroline was perfectly apt and suddenly, apparently she's not. And we joke about that. What is he supposed to do with that when in fact he thought Caroline was kicking his butt but now he's supposed to be the smart one?

This is the tool we're using [shows slide of imaging machine], people lie in here in the dark. I study emotion. I study facial expressions specifically. This gets interesting because men and women can end up in very different places on an emotional scale, and we'll talk a bit about that. The reason you study this is because in a functional brain imaging study you can get some pretty circumscribed accreditations to an afraid face versus other facial expressions. So the brain tells you that it can break down these stimuli and really evaluate them very quickly. We can show those stimuli subliminally so that you don't even know that you've seen them and we get pictures that look just like this as well. This is a very automatic and important system for threat assessment in your brain. You study facial expressions in humans because it's easy, it's innocuous and because you can't study it in animals.

Here's [sic.] some things to think about when you see a gender study around brain imaging. This one, we could stop right here and just go home. This one is in every one you've seen. And this is just about money and federal funding, okay? "In the present study, a cross-sectional design was used with healthy children ($n=7$), adolescents ($n=12$), and adults ($n=10$) who underwent functional magnetic resonance imaging (fMRI) during a task that required perceiving fearful faces. Males and females differed in the asymmetry

of activation of the amygdala and prefrontal cortex across the three age groups” [Kallgore et al. 2004]. So we’re not even dealing with seven, twelve and ten. We’re dealing with four versus three, six versus six if we’re lucky, and five versus five. You don’t even have to; I don’t have to show you these data. Right? This is ridiculous. Okay? These sorts of Ns. And they are in every study that’s out there.

This ephemeri is pilot data for the masses. That’s what it is. Everything we do, we won’t get funded – we don’t get money to have an N greater than twenty. Twenty is the largest N I’ve ever published. That’s okay if you have one group and you’re making them do something different within that group and using themselves as their own baseline, you can get away with that. This group of people compared to that group of people, these different brains, which aren’t going to normalize into the same space – you’re going to start talking about differences? It’s a very, very different and tough statistical story to tell. The Ns that I need to tell a within subject story are up around twenty. Now we’re talking power analyses here. You have a huge statistical power problem here. You’re going to find lots of interesting things, but you’re not going to know what any of them mean. And we already know that when sixteen or seventeen of these studies pile on top of each other and someone goes back and does a meta-analysis with the proper statistical controls, none of these effects ever hold up.

Post-hoc explanation is the way [that] most of these studies are run. They’re run and then you hear about them, right? This study [slide summarizes Canli et al. 2002] showed male and female subjects highly emotional pictures and then later they were given a surprise

test for memory. And what you find is that women remembered more of the pictures later than men did. And then we see differences in the brain. Men activate more structures. That's the first story. Men activate a lot more of their brain and they use their right amygdala – amygdala is an emotional area of the brain, it's experiencing it's fifteen minutes right now. Women activated significantly fewer structures. That's the other story; perhaps they're more efficient at this. And they use their left amygdala. Okay?

The study gets run again by somebody else two years later. The exact finding gets replicated. There's only one problem, in this study the men remembered more. Okay? So the story was we had a wonderful post-hoc story. Of course women are activating their left amygdala because language is on the left side and when they encode these pictures they use a verbal strategy because women are very verbal. And men, they're using their right amygdala because that's the global, spatial area and they're not using a verbal strategy. It's not as efficient they need to use more brain areas.

Here we replicate the exact same finding, so we're not saying it's not real, we're saying we don't know what it means. You didn't predict it before hand. You told us a wonderful story after the fact. And this is exactly what we should expect to have happen. If this isn't what was supporting the greater memory for women so that you've got the same finding and the finding flipped, and now you can't even trust the first thing that women will remember more of these things than men. And again, the Ns here are somewhere around twelve.

Structural differences in the brain, you'll hear a lot of these types of findings. I'll give you an example of one. This is actually a very, very robust finding. It probably is a good example of what this entire field rests upon. This is how organized [slide depicts diagram of brains], how many convolutions there are in the cortex, how many gyri there are. So cortical complexity is what we're talking about. This by the way is how we tell the difference between, how we talk about our brain versus a rabbit brain. We have more of these gyri. It's more complex. Dolphins actually have more than we do, fit that in with your theory please. And what you find is that males have less gyri, less convolutions than women do. This is a measure of that sort of complexity you have 2.162 versus 2.168.

You should laugh at yourself ... we don't know what these numbers mean and how they're arrived at. I can tell you there are sixteen different processes where a mistake can come into this. You stretch it; somebody counts, on and on. In the paper they never mention if the person who was doing the counting was blind to whether they were counting female or male brains. That's like [the] number one rule. I will say this though, this is why this is actually statistically a very robust effect: 2.162, the range is [2].15 and [2].164. And the female range starts at [2].165. There is no overlap in the range. Still, this is not a large magnitude. So this is the kind of study where you would need an N, again these Ns are in the thirties, you would need an N in the one thousands to I think have the statistical power to be telling this sort of a story. And you can draw a nice picture where this looks a little less but you know those are not real data there.

What about me? I know that you were waiting. What we study is projection. I am a walking projective test myself. And that's what I study with my subjects. You will impose order on this [slide depicts a Rorschach ink blot card]. You will not tell me about random ink. You will impose order on that, you will either tell me about lying under a tree or someone behind you in an alley. And that tells me something about your bias. And you will impose order on that [referring to another ink blot], you will tell me about a car coming at her or her walking in on a birthday party. And since I study valence, what I find out in the amygdala is that it can think these faces are negative, you have high activity here [slide depicts brain image]. And if you think they're positive you have low activity here.

I've had a thousand people come to me and tell me that I must have a gender difference in here and what it was. Everybody's answer is different. And if I break the data down by gender, the blues are the males and the females are in red [slide depicts graph of activity]. It is true that my bottom two people are female and my top two people are male. But that's four out of a group of eighteen, and at fourteen people that you can't tell apart. That's how these things always go, there is way more overlap than there are differences and we persist in talking about these things. Apparently males, if we wanted to go with that, are the pessimists and the females are the optimists. Actually the depression literature would have made the exact opposite prediction. So I basically would tell you this isn't real and it's very difficult to start trying to tell these stories with these small amounts of data.

We talked about getting a finding and having an explanation. If you do, there are studies that have a priori predictions. And sometimes they come from really poor places, like intuition. “Women were chosen in this study because they are more likely to report intense emotional experience” [Canali et al. 2000]. If I ever said that out loud in my laboratory I’d be killed. Because too bad they didn’t know about this study where men have a greater activation in these same areas that you cared about, so the data do not support your intuition.

Sometimes, though, predictions can come from not good places but what look like real places and maybe you would try to follow them up with some actual data. So a body image, an eating disorder are more highly represented in female populations. That’s not a bad place to start. Now just be careful with how you design your study and so on and so forth. It’s the same thing for depression, it’s much more prevalent in women. And that’s why people go down this road and why you need to do studies that fix all those things we just talked about if you want to try to tell these stories. It’s the opposite for things like autism in males. And so there would be real reasons to go down this road, it’s not a bad thing to go looking for these differences. But I think when you see these brain activation slides and there’s this tiny little spot that’s a gender difference, remember that’s a subtraction of one condition from another. If three percent of the screen is different then that means ninety-seven percent of the screen was the same, and where is your focus? Again, for me it’s about sticking with the numbers and that lets people get on with their own lives.

I think if I had one sentence in this talk it would be on the three hypotheses. It was this one: “the empirical problem here is that girls are persisting longer and longer” [Lawrence Summers]. This was in a part of the speech where he puts that word persisting. Persistence? Excuse me? It’s like, I’m sorry you’re not choosing, you’re not achieving. What he’s referring to is you’re getting further. In counter to this hypothesis you’re making it a little bit higher each year and every decade you look at it you’re a little bit further and further along. But his final point is eventually you’re going to spawn and get out of the field because that’s what the field will do to you. I would close with these words and say here’s the one sentence that I agree with [slide reads: “I would like nothing better than to be proved wrong,” Lawrence Summers].