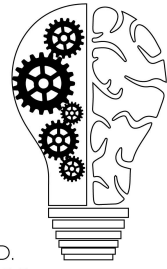


Episode 068: IQ: Predictability, Influences, Genes, Environment, & Trauma

Nelson Horsley, David Puder, M.D.



DAVID PUDER, M.D.
**PSYCHIATRY &
PSYCHOTHERAPY**

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There are no conflicts of interest for this episode.

On this week’s episode of the podcast, Nelson Horsley (a 4th year medical student) and I talk about the IQ - if it is a predictor for a successful life, what influences it acutely, does it change over a lifetime, and how and why it is an important measure in psychiatry.

What is intelligence?

A definition signed by 52 intelligence researchers:

A very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly, and learn from experience. It is not merely book learning, a narrow academic skill, or test-taking smarts. Rather, it reflects a broader and deeper capability for comprehending our surroundings—“catching on,” “making sense” of things, or “figuring out” what to do. ([Gottfredson, 1997](#))

Why is IQ so controversial?

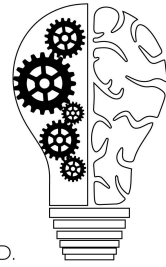
As mental health professionals, IQ can certainly give us a good idea of where the person is functioning at a certain point of time. For example, If there are disparities between intelligence and grades, we know ADHD could be a contributing factor. Measuring IQ can be helpful in many instances in better understanding our patients. Unfortunately, terrible misuse in the past has made many smart people cautious about their use. Some people want to do away with IQ testing altogether.

Unfortunately, in the dawning understanding of mental health, involuntary sterilization of certain mental patients was implemented in the United States in the 1900s and spread to Europe, Japan, and Canada by the 1920s. It became popular with the Nazis in the 1930s. They later used US eugenics to justify

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atrocities of the holocaust at Nuremberg. In the United States, 64,000 sterilizations took place between 1900 and 1964, with some additional 10,000 up to the present day, targeting the poor, mentally ill, and “feeble-minded” ([Lombardo, 2007](#)).



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The association with eugenics as well as other deeply-felt concerns (accuracy, cultural bias, group differences, IQ fatalism), have made human intelligence and IQ testing a very controversial topic over the past several decades ([Carl and Menie 2019](#)).

Currently, there is growing distrust regarding IQ in the general population, and a movement away from standardized achievement tests in college and graduate school admissions ([Gottfredson, 2005](#)). You’ll hear misperceptions like [that IQ is hopelessly biased, only predicting how people will perform on IQ tests](#). We intend to show that these perceptions are wrong, and that IQ is a valuable predictive measure that deserves use both for research purposes and for patients.

What is the history of IQ testing?

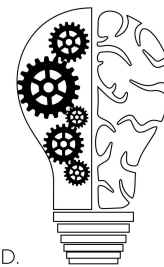
Measuring IQ has taken several different forms over the centuries. It began in the mid 1800’s when French physician Edouard Seguin classified children with intellectual disability for training ([Boake, 2002](#)). Intelligence testing went mainstream when the Army designed tests for service in WW1 when 83,500 examinations were performed on adults.

David Wechsler served as a corporal in WWI after completing masters at Columbia. He worked as a psychological examiner and became convinced of the inadequacy of existing intelligence tests when he tested recruits who had functioned normally as civilians that failed Army group exams and scored very low on the Stanford-Binet test.

He created a newly designed test that made multiple contributions to all later tests, designed foremost for adults. He changed IQ from mental/chronological age as in the Stanford-Binet model to the current standardized score with mean 100, SD 15. His test incorporated a large variety of existing tests, validated

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them in a large population, and was one of the first to merge performance and verbal tests into the same scale. Because of its strengths, the test spread rapidly and is the most common IQ test in use today. Extensive efforts have been invested in making sure the Wechsler is valid, and is currently standardized against a represented group of Americans. ([Canivez et al 2017](#)). The Wechsler is currently on its fourth revision (1955, 1981, 1997, 2008), with a [5th revision expected in 2021](#).

How do IQ tests measure intelligence?

IQ tests challenge subjects to efficiently and effectively complete a wide array of tasks that measure individual mental capacities such as memory, executive function, knowledge, processing speed, and problem solving ([Nisbett et al, 2012](#)). Researchers have found that all these abilities tend to correlate strongly with each other, and that the results from individual tests can be compiled into a latent factor for intelligence, dubbed *g* ([Spearman, 1927](#), [Gottfredson, 2002](#)).

Some tests capture *g* better than others. IQ tests are designed to capture *g*, but other factors help explain the final results as well. The average compiled IQ follows a standard distribution, with a mean defined at 100 IQ points and a standard deviation is always 15 points ([Nisbett et al, 2012](#)).

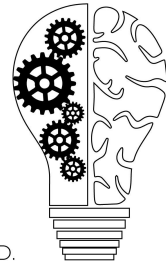
Current IQ testing

The [Current WAIS-IV test](#) is divided into four indexes of intelligence-

- Verbal Comprehension Index (VCI), Subtests
 - **Similarities: Abstract verbal reasoning** (e.g., "In what way are an apple and a pear alike?")
 - **Vocabulary:** The degree to which one has learned, been able to comprehend and verbally express vocabulary (e.g., "What is a guitar?")
 - **Information:** Degree of general information acquired from culture (e.g., "Who is the president of Russia?")
 - **Comprehension:** Ability to deal with abstract social conventions, rules and expressions (e.g., "What does *Kill 2 birds with 1 stone* metaphorically mean?")

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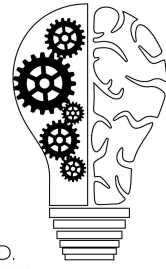
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- Perceptual Reasoning Index (PRI)
 - Block Design: Spatial perception, visual abstract processing & problem solving
 - Matrix Reasoning: Nonverbal abstract problem solving, inductive reasoning, spatial reasoning
 - Visual Puzzles: non-verbal reasoning
 - Picture Completion: Ability to quickly perceive visual details
 - Figure Weights: quantitative and analogical reasoning
- Working Memory Index (WMI)
 - Digit span: attention, concentration, mental control (e.g., Repeat the numbers 1-2-3 in reverse sequence)
 - Arithmetic: Concentration while manipulating mental mathematical problems (e.g., "How many 45-cent stamps can you buy for a dollar?")
 - Letter-Number Sequencing: attention and working memory (e.g., Repeat the sequence Q-1-B-3-J-2, but place the numbers in numerical order and then the letters in alphabetical order)
- Processing Speed Index (PSI)
 - Symbol Search: Visual perception, speed
 - Coding: Visual-motor coordination, motor and mental speed
 - Cancellation: visual-perceptual speed

Researchers know other factors besides general intelligence go into IQ scores. Scores are affected by the level of effort put into them and can be increased by providing financial incentives. In one study, incentives increased IQ scores by 0.96 SD among individuals with below-average IQs at baseline and by only 0.26 SD among individuals with above-average IQs at baseline ([Duckworth et al 2011](#)). Duckworth estimates that 25% of scores are measuring non-intellectual traits, with the rest reflecting general intelligence. Scores can be artificially lowered by missing sleep ([Lim and Dinges 2010](#)), acute mental illness ([Keyes et al. 2016](#)), or preoccupation with other stressors ([Mani et al. 2013](#)).

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And can be increased by providing financial incentives. Incentives increased IQ scores by 0.96 SD among individuals with below-average IQs at baseline and by only 0.26 SD among individuals with above-average IQs at baseline ([Duckworth et al 2011](#)).

Verbal IQ tests ask general-knowledge questions that depend at least somewhat on language competence and cultural understanding ([Boake, 2002](#)). In addition, autism and illnesses like depression that impair concentration can cause an underestimation of true ability ([Grondhuis et al. 2018](#), [Mcdermott and Edmeier, 2009](#)).

To address these issues, many nonverbal performance IQ tests have been developed (especially important for those with autism or non-native speakers). Performance IQ tests test pattern recognition and are used independently as well as to supplement verbal IQ tests like the Weschler.

Does IQ have *test-retest reliability*?

Different tests have different reliabilities- The Weschler is the most studied test. Researchers find that the standard error of measurement for the Weschler-IV is about 3 IQ points- eg, if you score a 110 the odds of scoring between 107 and 113 is 68% ([Van Blerkom 2008](#),).

Do IQ tests have predictive value?

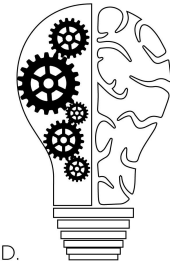
On a sociological level, IQ scores are one of the best predictors of a wide range of important future outcomes like test scores ([Deary et al 2007](#)), educational attainment ([Lynn and Mikk 2006](#), [Strenze 2007](#)), mental and physical health ([Johnson et al. 2011](#)), and to a lesser degree future income. In a meta-analysis separating the best of 65 data sets from the US and Europe, [Strenze \(2007\)](#) studied the long-term relationship between the highly intercorrelated traits of IQ, socio-economic background, and educational attainment (years in school). He found a strong correlation of cognitive scores with educational attainment (.56) and current SES (.45), and a weaker correlation with income (.23).

Isn't it possible that researchers were measuring the wrong thing? What if researchers were really just measuring parent's education, school scores, or socio-economic background and IQ scores were just dependent on these factors?

Well...

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Table 1
Predictors of socioeconomic success

	<i>k</i>	<i>N</i>	<i>r</i>	rw	<i>p</i>	S.D. <i>r</i>	S.D. <i>p</i>	CV 95%	CI 95%
Correlation with education									
Intelligence (all studies)	59	84,828	.46	.48	.56	.12	.10	.36/.75	.53/.58
Intelligence (best studies) ^a	20	26,504	.49	.48	.56	.10	.07	.42/.69	.52/.59
Father's education	72	156,360	.40	.42	.50	.14	.13	.25/.75	.47/.53
Mother's education	57	141,216	.37	.40	.48	.13	.13	.22/.73	.44/.51
Father's occupation	55	147,090	.34	.35	.42	.09	.07	.27/.56	.40/.44
Parental income	13	64,165	.29	.31	.39	.10	.11	.17/.61	.33/.46
SES index	17	69,082	.41	.44	.55	.12	.10	.35/.75	.50/.60
Academic performance	27	49,646	.48	.47	.53	.09	.07	.39/.68	.50/.56
Correlation with occupation									
Intelligence (all studies)	45	72,290	.37	.36	.43	.13	.08	.28/.57	.40/.45
Intelligence (best studies) ^a	21	43,304	.41	.38	.45	.09	.05	.35/.54	.42/.47
Father's education	52	132,591	.27	.26	.31	.08	.06	.19/.43	.29/.33
Mother's education	40	116,998	.24	.23	.27	.08	.07	.13/.41	.25/.30
Father's occupation	57	146,343	.28	.29	.35	.10	.08	.19/.51	.33/.37
Parental income	12	60,735	.19	.21	.27	.07	.10	.07/.46	.21/.32
SES index	16	74,925	.30	.31	.38	.08	.08	.22/.54	.34/.42
Academic performance	17	54,049	.33	.33	.37	.09	.07	.23/.51	.33/.41
Correlation with income									
Intelligence (all studies)	31	58,758	.21	.16	.20	.09	.11	-.01/.40	.16/.23
Intelligence (best studies) ^a	15	29,152	.22	.19	.23	.08	.06	.10/.35	.19/.26
Father's education	45	107,312	.16	.14	.17	.09	.08	.01/.32	.14/.19
Mother's education	37	93,616	.13	.11	.13	.10	.07	.00/.27	.11/.16
Father's occupation	31	98,812	.16	.15	.19	.08	.10	.00/.38	.15/.22
Parental income	17	395,562	.16	.16	.20	.06	.07	.06/.33	.16/.23
SES index	14	64,711	.15	.14	.18	.07	.08	.03/.33	.14/.22
Academic performance	14	41,937	.11	.08	.09	.07	.08	-.07/.24	.04/.13

Note. *k* — number of independent samples, *N* — number of individuals, *r* — average correlation, rw — sample size weighted average correlation, *p* — sample size weighted average correlation corrected for unreliability and dichotomization, S.D.*r* — standard deviation of *r*, S.D.*p* — corrected standard deviation of *p*, CV 95%–95% credibility intervals of *p*, CI 95%–95% confidence intervals of *p*, SES — socioeconomic status.

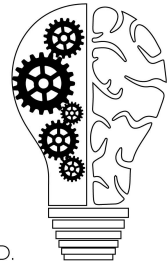
^aBest studies are the ones where intelligence is tested before the age of 19, and socioeconomic success is measured after the age of 29.

As you can see from this chart, a simple IQ test that can be administered in a few hours (red) does a better job of predicting years of school, occupational status, and personal income than a person's socioeconomic background factors (gold), or years of education (yellow)!

But notice that each of these factors are more than a partial explanation. In the case of income, neither academic performance, IQ, or background explain more than a fraction. Clearly there is a lot more that contributes to success than can be quantified with these variables!

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How does IQ change over a lifetime?

IQ is relatively stable over a lifetime. The correlation between test results at age 11 and test results at 90 was about .56 ([Deary and Starr 2013](#)). IQ Tests of young children and the elderly are generally less accurate ([Nisbett et al, 2012](#), [Deary and Starr 2013](#)). Generally fluid intelligence (learning and problem-solving ability) peaks in the late teens to 20s before slowly declining, while crystallized intelligence (knowledge and experience) peaks around the 40s or 50s ([Nisbett et al, 2012](#)).

Exercise appears to slow age-related decline ([Hillman et al 2008](#)); depression ([Dotson et al 2008](#)) and chronic stress ([Booth et al. 2015](#)) appear to hasten it. Engaging in intellectual activities (problem solving, reading) appears to increase your IQ “set point”, but doesn’t slow age-related decline ([Staff et al 2018](#)). Heavy marijuana over a long time lowers IQ in adults ([Meier et al. 2012](#)).

What determines IQ?

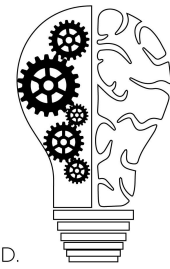
Most people have a simplified view of causation. It’s easy for people who haven’t studied this complicated subject to come away with overconfident impressions of a field with lots of uncertainty. It’s common to hear phrases like “50% nature, 50% nurture” without understanding the context of the studies these numbers are drawn from. To see why this is tricky, let’s look at extremes. If the environment between two individuals was theoretically exactly the same, than any difference in intelligence found would be 100% genetic. When genetically identical individuals (identical twins) get different results, the difference is 100% environmental.

In Western populations, the consensus is indeed that half of the variance in IQ is due to genetic differences ([Nisbett et al, 2012](#)). Given what we just said about context, how can we be confident in this?

We know this from twin studies that compare monozygotic twin pairs who share all their DNA with dizygotic twins who only share half ([Bartels et al. 2002](#)). We can use this difference when comparing scores to calculate the role genetics plays.

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What do twin studies find? At least for white Western populations, it's indeed true that about 50% of IQ differences are genetic, about 50% environmental. Out of the roughly 50% of IQ explained by environmental factors, approximately 20% is explained by shared environmental factors (what the twins have in common—socioeconomic status, living area, parents, schools) while approximately 30% is explained by nonshared environment (everything else that's dissimilar between twins raised together—friends, differential parenting, different life experiences and choices, and luck—as well as all the measurement error in data collection and testing).

The numbers gleaned from twin studies are in reference to differences across a population—*between* population differences aren't accounted for. As an analogy, seeds in rocky soil won't grow as high as seeds in good soil, but if you are studying only one population by itself, you wouldn't see or measure that factor in your calculations.

Many environmental impacts on IQ affect large parts of the population and show the limits of twin studies—air pollution [Shehab and Pope \(2019\)](#), education [Rindermann and Coyle \(2017\)](#), iodine deficiency ([Qian et al. 2005](#)), lead [Aaron et al. \(2017\)](#), parasites [Eppig and Thornhill \(2010\)](#), and other neurotoxic contaminants ([Lam et al. 2017](#)) will show up as nonshared environment contributors or *not even included in calculations* if they are ubiquitous enough. In other words, if a harmful effect is lowering IQ all groups in equal measure, there won't be any variation that needs explanation until we compare the new-found groups of those exposed to those not.

Despite this, it is clear that genes have a substantial role in intelligence. [Plomin and DeFries \(1980\)](#) find that the correlation between parent/child IQs are .35-.5. Correlations are higher between child and biological parent (.31-.45) than adoptive parent (.23-.25).

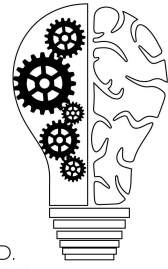
Researchers have begun to study some of the genes involved, but right now can only explain 5-11% of the variance using current methods ([Savage et al. 2018](#), [Lee et al. 2018](#)). Additionally, genes could cause intelligence differences in ways that are dependent on the environment rather than affecting brain development. For example, if genes for a nice smile cause a child to get more attention from teachers and this attention contributes to a higher score on IQ tests, this would be counted as genetic despite having nothing to do with the brain.

Epigenetics appear to play a role as well ([Kaminsky et al. 2018](#)), but the field is in its infancy.

How do mental illnesses affect cognition and IQ?

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Most people with mental illnesses exhibit general cognitive deficits compared to healthy controls ([Keyes et al. 2017](#), [Gale et al. 2010](#)). In some cases, like schizophrenia, deficits are global, affecting all aspects of cognition ([Fioravanti et al. 2005](#)). In others, cognitive deficits are specific to particular subtasks, such as poor visual spatial working memory in ADHD ([Westerberg et al. 2004](#)). In illnesses like depression, lower cognitive scores appear to be related to decreased test-taking motivation ([Gotlib and Joorman 2010](#)). With most mental illnesses, significant cognitive gains can be seen with treatment ([Hagger et al. 1993](#), [Herrera-Guzman et al 2009](#), [Biederman et al. 2012](#)).

In turn, higher IQ seems protective against mental illness, with higher-IQ people expressing less severe symptoms and seemingly better able to avoid psychiatric hospitalizations ([Gale et al. 2010](#)). We have a saying in our department that high functioning individuals are sometimes underdiagnosed and can continue to function in their jobs with ongoing suicidal thoughts. So this finding might illustrate how highly intelligent people are harder to treat because they superficially don't appear as ill.

Can IQ change?

IQ is relatively stable over a lifetime ([Deary and Starr 2013](#)), but is dependent on many environmental factors, some of which we have influence over.

What environmental factors contribute to IQ in the long-term?

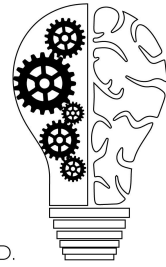
Prenatal

Maternal smoking and alcohol

[Streissguth et al \(1989\)](#) interviewed 1,529 pregnant women about lifestyle, diet, drinking, smoking. The children who mothers who had 3 drinks a day had 4.8 less IQ points at age 4, with alcohol affecting both verbal and performance IQ. Verbal IQ and performance IQ were not significantly related to smoking (-0.1 IQ points, not significant). However, controlled for birth weight 6-10 cigarettes a day is associated with

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mean birthweight 320 g lower ([Katoaka 2018](#)), and by controlling for birth weight, [Streissguth et al \(1989\)](#) may be “controlling out” the effects of smoking.

Birth weight

[Matte et al. \(2001\)](#) Found that mean IQ increased monotonically with birth weight in both sexes across the range of birth weight in a linear regression analysis of one randomly selected sibling per family (n =1683) with adjustment for maternal age, race, education, socioeconomic status, and birth order. Gains were 4.2 IQ points for boys per 1000g up to 4.2 kg, and 2.8 points per 1000g for girls.

Fluoride

[Green et al. \(2019\)](#) found significant association between estimated maternal urine fluoride and tap water consumption and lower IQ for boys and girls ($p=.04$). The test did not have enough information to say anything definite, but it is concerning and an area for future research.

Early Childhood

Breastfeeding

[Kanazawa \(2015\)](#) found that the relationship with breastfeeding was an increase in .3 IQ points for every month of breastfeeding, which diminished to a .13 ($p=.007$) for every month after IQ was controlled for (controlling for other factors increased assoc to .161)

Adoption

[Kendler et al \(2015\)](#) found that educational level was substantially higher in adopted families, which led to an increase of 4 IQ points. Each quintile of biological-parent education was associated with 2.7 IQ points in adopted children. Each additional unit of rearing parental education was associated with 1.7 IQ points. Adopted-away siblings had an average 4.4 IQ point advantage over home-raised siblings. The effects of parental education suggest the role of education in shaping not only the outcomes for subjects, but their children as well.

Environmental effects on IQ

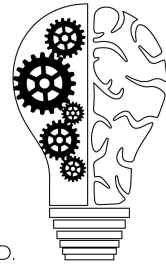
Abuse and dysfunction

[Ritchie et al. \(2011\)](#) found a significant relationship with age, educational attainment and IQ. It found that sharing of parental problems (OR of having scores below a cut-off on verbal fluency and visual memory test = 1.68, $p =.004$) and parental loss (OR= 1.43, $p=.035$) were significant predictors of poor performance later in life. Reporting experience of physical, mental, sexual abuse was associated with

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lower risk of cognitive impairment (OR=.58, p=.053) (Is there a resilience factor here?) The **most neglected** 6% of the population had a 7 IQ lower cognitive score at eighteen years old and a 4 IQ lower score at fifty years old, after adjusting for confounding factors and mental health. Mental health is also negatively affected by neglect, suggesting the effect could be even stronger.



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How much worth should we place on the IQ?

IQ is a useful tool for measuring mental ability, and is predictive for a host of important factors that depend on cognition. It can quantify how people's mental capacities are damaged and improved, in which manner, and to what degree.

In the medical profession, scales are ubiquitous. We use scales for awareness, physical fitness, and severity of nearly every kind of disease, because they help us make better decisions. In the mental health field, tests of intelligence help establish patient's baseline mental abilities and can be trended to see the effects of mental illness over time, which we'll talk about later.

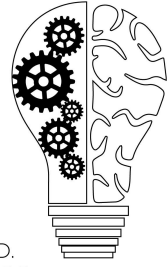
A lot of people worry about IQs, but the [test results alone aren't very predictive on an individual level](#). For example, you are definitely set up with privileges if you come from a high SES background, but it is no guarantee of success, and coming from a less privileged background is no guarantee you'll be stuck there. An IQ score could help you decide what kind of career you could excel at, but is only one factor: it is neither a guarantee of success nor a consignment to failure.

A large part of IQ is genetic ([Nisbett et al, 2012](#)). Our culture places a high value on intelligence, much like it values traits like height, attractiveness, social status, and wealth. None of these traits are evenly distributed, and most are largely out of control, so it doesn't make sense to attach them to human dignity and worth, which belongs to everyone.

Conclusion

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Important take aways from this first episode and article on IQ:

- IQ research is complicated and there is a lot of nuance to interpreting individual IQ scores
- We should consider that IQ and your parent's socio-economic status is only slightly correlated with income (0.21 and 0.15 respectively)
- People with low effort, poor sleep (like obstructive sleep apnea), acute stress, acute mental illness will score lower on IQ tests
- Therapy and treatment of mental illness can increase IQ scores by allowing the person to have a more functional brain
- On a society level, we need to look at how toxins and environmental factors influence IQ to create a healthy society
- We should not judge people who have a "low IQ score" who come from disadvantaged backgrounds because with proper nutrition, secure attachments, working through traumas, exercise, and opportunities they will have huge improvements from their starting point.

In the next episode, we hope to go more in-depth into how various mental illnesses affect cognition, and the role treatment has in correcting these deficits in likely another 2 hour deep dive!