Article • Clinical Guide to Einsteinian Low Vision Rehabilitation: Part 2 of 4

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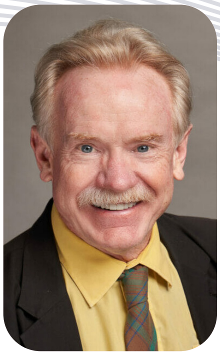

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The Longest Journey Begins with the First Step

"The noblest distinction of man is his passion for knowledge."
–Will Durant

"Professor McIver, we have a question for you," said the spokesperson for the small cadre of low vision students at the office door. "May we come in?"

"Certainly." Replied Professor McIver. "What is on your mind?"

"Well," began the first student hesitatingly, "we have a conundrum. It seems to us that everything we have been taught so far regarding visual acuity (VA) is that 20/20 is perfect vision, and that 20/20 should be our goal for each patient, but that seems impossible for patients with low vision, and on top of that, we don't even know where 20/20 came from."

"Well, first, 20/20 is not nor ever has been 'perfect vision,' and it is not even vision, it is sight. There is a difference between the two, with sight being the ability to distinguish angular subtense and vision being the brain's cognitive gestalt. Definitions aside for now, however, I think the best way for you to gain a good understanding of '20/20' is to dive deep into 'The Source'. There is a very interesting story of how we came to 20/20 and what it really means. Let's go meet Robert Hooke from history."[7]

"Come in," Robert Hooke said to the group of applicants. "As you should know from the notice I posted, I am looking for an assistant with good sight to help me with my studies of the star systems." It was the late 17th century, and the nascent concept of experimental scientific method was rising. The Royal Society of London was home to a number of great scientists, including Robert Boyle and Isaac Newton in addition to Robert Hooke.

It was clear and dark that night, unusual for London, as Robert Hooke took his apprentice applicants out to view the night sky. Taking them aside, one by one, he directed their attention to Ursa Major (Big Dipper) and asked them to count the constituent stars.

"I am sure there are seven," many of the hopefuls said one after another, only to hear, "Thank you, but you are not correct. You may go," Robert Hooke disappointedly said, again and again.

"I count eight," one candidate finally announced, and he was hired on the spot.

At last!" Hooke exclaimed, "I have found an assistant with good sight! I can always count on Alcor and Mizar to be arbiters of good sight, as the stars are static and will always be available to me in the future when I need new apprentices."

"What are Alcor and Mizar?" the student spokesperson chimed in, bringing the group back to the present.

"Why, those are what look like a binary star in the handle of the Big Dipper," Professor McIver said, stepping away from The Source. "You see, the angular separation, combined with the brightness differential between Alcor and Mizar, is 1′ of arc, or the minimum angle of resolution of a 20/20 letter. Just imagine for a moment how odd it is that our definition of good visual acuity goes back to an employment test from almost four centuries ago," Professor McIver told his study group. "20/20 is nothing more than the essential angular subtense between the stars Alcor and Mizar in the Big Dipper used by Robert Hooke to qualify an apprentice for employment. But it marked an important point of departure by defining what good sight is and establishing a standard that could be replicated anywhere in the Northern Hemisphere."

"I don't believe I have ever heard much of Robert Hooke," another student exclaimed, "even though I was a science major as an undergraduate student."

"That is not surprising," Professor McIver explained, "as Robert Hooke had a significant falling out with Isaac Newton, accusing Newton of plagiarizing his work. As you might imagine, that did not sit well with the powerful Newton, who, as head of the Royal Society, it has been suggested, canceled Hooke even to the point of having his portrait 'disappeared'. Whether that story is true or just apocryphal, we now know that

Robert Hooke's scientific work with astronomy and microscopy was groundbreaking, and we owe a lot to him, including our modern-day definition of good visual acuity. Remember, however, 20/20 is arbitrary and the result of an old employment test; it is not an absolute standard of 'good sight,' so do not, as good doctors with psychometric integrity, use it as a cutoff for refraction, an ideal goal acuity, or best-possible vision."

Noticing

"You can observe a lot just by watching."

–Yogi Berra

"Have you ever noticed," Professor McIver began to the class, "that so much of what is done in the health care professions is that which was done in the past and handed down from generation to generation of practitioners without question? Don't get me wrong, there is a lot of good, evidence-based practice being done, but so much of our daily care has not changed significantly in decades, as there is just not good evidence for everything we do."

"Why are you telling us this?" Hugh from the back asked. "If it's been done for decades, shouldn't it be just fine to continue?"

"There it is!" Professor McIver exclaimed. "While it might be "fine", we need to keep our eyes open for changes in our process of care if we are to consistently improve. There is a word for continuous improvement in Japanese: it is 'kaizen.' It is a mindset, a philosophy, and a methodology of making ongoing step-by-step progress and requires an open mind to keep watching for opportunities. Most steps of improvement are small and incremental, but sometimes those steps of improvement are large and might even be big enough to provide a chance for a punctuation of the equilibrium. For instance, back in the 1970s, a revolution in measuring visual acuity was largely sidelined by the inertia of years and years of recording acuity in the established, classic manner. Even though the old way no longer met the high standards of psychometric integrity, it had always been considered 'fine' and so endured (Bailey I, Lovie-Kitchin J, 2013). That should no longer be considered satisfactory for modern optometrists who adhere to psychometric integrity."

"Listen, why don't we open up 'The Source' and see where the revolution came from and how we can still access its power in caring for our partially sighted patients?"

"That sounds intriguing," Hugh said, speaking for many in the class, "but until it can be demonstrated as superior, I still think 'fine' is 'fine'."

"We'll see if you still think so when I am done. So, here we go," Professor McIver replied. "Math was advancing in the late 16th century when John Napier discovered logarithms and used them as an aid in calculating the large numbers needed for astronomy. By the early 17th century, he invented the calculating tool known as Napier's Bones as a forerunner to the slide rule. The slide rule was invented by William Oughtred[8] and eventually allowed three decimals of accuracy once Isaac Newton, Robert Hooke's nemesis, added a slide a few decades later. The slide rule made modern industrial society possible and was de rigueur for all professions until the early 1970s, when affordable electronic calculators came on the scene as inexpensive and widespread for performing complex calculations. 'So what', you think, right?" Professor McIver asked rhetorically.

"Exactly," Hugh sighed, waiting for the end of the session. "It's been a nice history lesson, but what does it have to do with patient care?"

"Glad you asked," Professor McIver continued, "as it has everything to do with rational decision-making in the clinic. Recall that, as you have been taught so far, we have vision charts and refraction techniques which were developed for fully sighted patients. The large, irregular-letter-size jumps on the chart and the 0.25 D lens steps were fortuitously workable for them in refracting the fully sighted. When we begin dealing with partially sighted patients, however, those systems break down quickly, causing frustration for both patients and doctors, and is one of the main reasons, in my opinion, that many practitioners shun low vision care."

"So, let's continue to explore how math can be our friend in low vision rehabilitation. In the 19th century, Hans Weber observed that human sensory ability to detect change was proportional to the original stimulus. The original stimulus for measuring sight is the 1′ of arc that Robert Hooke posited as good vision. Proportional change can be thought of as changes in letter size as well as dioptric power. Do you see the logarithmic function? Logarithms allow math to be simplified by making proportional change into additive change. Now, since it is easier for human brains to add and subtract rather than to multiply and divide, we can glimpse an avenue to lever the principles of 'good sight' that Robert Hooke defined with the rational chart letter sizes and power progression that Weber discovered. It has since been determined that the proportional change for humans to detect a change—a just noticeable difference, or JND, if you will—is when the stimulus changes by 0.1 log from a baseline. If we take Robert Hooke's 1′ of arc subtense as standard good sight, we can quickly build a visual acuity chart, a rational vision chart, with steps between letter sizes of 0.1 log steps. Bailey and Lovie did exactly that in the late 1970s with the Bailey-Lovie chart, the first rationally designed vision chart that incorporated human abilities as the guiding principle. The ETDRS chart then slightly modified the Bailey-Lovie chart and became the standard way to measure visual acuity ever since. In actuality, when we think deeper about how these charts were developed with logMAR principles, we find that they are calculating devices like a slide rule! Slide rules were the calculating devices that made possible the industrial revolution. They ruled the calculating world until the 1970s, when electronic devices took over. Therefore, using the slide rule properties of the logMAR, we can make accurate predictions of power, working distance, and telescopic power with nothing but a logMAR chart. But I am getting ahead of the progression of knowledge here; that is a lesson for another time. For now, it must be recognized that old charts and paradigms for measuring visual acuity only worked satisfactorily for fully sighted patients due to fortuitous circumstances, not scientific rigor. In order to properly take care of all of our patients, we need to break out of the old confines and embrace the power of logMAR thinking."

Hugh was quiet a moment, as was the whole class; then he said, "I for one cannot wait to see how to apply this, even though it seems a bit esoteric at this point."

"That is 'fine' for now," Professor McIver smiled. "The following lessons will explain more and introduce techniques, processes, and methods to apply logMAR thinking. Class dismissed."

Rationalizing Near Visual Acuity

"It ain't what you know that gets you into trouble, it's what you know for sure that just ain't so."

–Mark Twain

"I am glad we got this little study group together," Professor McIver began. "You fourth-year students have had a decent amount of clinical experience by now and no doubt believe that you have a good grasp of visual acuity, what it means, and how to use it in patient exams. Distance VA (dVA) is pretty well standardized as being a Snellen fraction with numerator of object distance over a denominator of object size, always making sure we keep our units the same: i.e., metric vs. imperial. We commonly take that to be when tested at a distance of 20 feet, the patient can resolve a 20-foot letter: 20/20. Simple enough, and we all get that. We have already seen what that means in the most precise and psychometrically sound manner in an earlier lesson when we use non-standard test distances. As a related aside, it should be mentioned that "count fingers" is an abomination to psychometric integrity and should never be seen on a record as a form of visual acuity. Count fingers is an anachronism to be left for people who don't know what visual acuity means. You see, there are drastically different sizes of fingers, from 120 foot letter to 200 foot letter, as many different color fingers as there are people, and different contrasting backgrounds such as dark scrubs or a white clinic coat. If you can't get an acuity on the ETDRS chart at 2 meters, just grab a Feinbloom distance chart, and move closer to the patient. The Feinbloom chart goes all the way up to a 700 foot letter with high contrast and recognition numerals, so it is acceptable for very poor acuities. There is also the Berkeley Rudimentary Vision Chart for very reduced acuities. So, if I ever find you using "count fingers", I will require you to turn in your psychometric integrity membership card. As you might surmise by now, "count fingers" is a trigger for your Professor McIver, so avoid using it at all costs. That being said, today, I want this group to focus on near VA (nVA) and apply the principles of dVA to nVA.

You have each been working with near visual acuity for a while, and I want to hear your take on the various nomenclatures. We know there are four separate nomenclature terminologies in general use for recording near visual acuity, but we are interested in knowing what their differences are, their advantages and disadvantages, and which makes the most sense to use. Those four systems are:

1. Reduced Snellen (RS)
2. Point or 'n' units
3. Jaeger, aka J-System
4. M-Units

"While you may have had classes, labs, or clinics together, I want to make sure you know each other. By way of introduction, we have today in our group Rochelle, Ahn, Jesse Johnson (J.J.), and Logan," Professor McIver said. "Let's begin with reduced Snellen."

"Oh," exclaimed Rochelle, "let me take that. I find reduced Snellen so much easier than the other systems because it closely resembles distance Snellen, and I can know exactly what it means. The comfort level is great for me, and people outside our field can quickly determine what our report letters mean. Besides, a lot of electronic health records contain drop-downs in the nVA fields for reduced Snellen. RS just makes so much sense."

"I hear you saying, Rochelle," Professor McIver began, "that the convenience and emotional comfort of using RS makes it the best choice for you. I get that, and many practitioners prefer it too for just those reasons. Also, people outside optometry, such as nurses, teachers, OTs, and primary care physicians, have a warm feeling for thinking they know what RS means. But what actually does RS mean? It only has psychometric validity if the chart is held at the prescribed distance, but in standardized recording of RS, there is no place to note the working distance. This is a trap into which many people fall: not ensuring the working distance is the one specified on the near VA chart. Sadly, I see this happening more often than not. Let me give you an example: I observed a post-op tech who was assigned to give a one-day cataract patient her acuity test with a near chart. The tech removed the surgical pressure patch, handed the patient the near VA chart, telling her to hold the chart where she saw it best, and read the lowest line she could. Well, the patient proceeded to hold the chart at about 20 cm and read off the 20/25 line. The tech then recorded 20/25 on the patient's chart. It was at this point that I interrupted and told the tech that was not the correct acuity to record, and she rebutted with that was how the surgeon taught her. Clearly, neither understood nVA. I sensed a teachable moment and asked the tech to read the top of the chart where it was written, 'To be used at 16 inches or 40 cm.' The ensuing corrected working distance yielded a nVA of 20/50 that made much more sense given the state of dry maculopathy the patient had in that eye."

"Oh, I see what you are saying," Rochelle said thoughtfully, "Unless I record the working distance with RS, no one could know the actual nVA. I see now that it is a potentially misleading nomenclature if we are using RS without recording working distance to take a baseline acuity or follow up on disease progression."

"You got it!" exclaimed Professor McIver. "RS is only valid if it is recorded with the actual working distance. If it is not recorded that way, the value of the RS should be discounted. There is no way of knowing the true VA unless we know actual working distance and actual size of the optotype. So, to summarize, RS is a good-news, bad-news situation, where the good news is that we have a high comfort level using it, but the bad news is that RS is a trap waiting to happen if we do not record working distance with it."

"Now, on to the next nVA system of nomenclature, the point system, also known as 'n'. Ahn, would you take the advocate role, please?" asked Professor McIver.

"Certainly, and thanks for assigning me this one," Ahn commenced. "The point system originated centuries ago, when physical type sets on printing presses were used. That means it has a long history of being used in and by printing presses, books, librarians, and publishers. A single point is 1/72", so it is an actual size, not like RS, where we do not know the actual size or working distance. Interestingly, in word processors, the font size is roughly equivalent to 'n', so in communications with teachers of the visually impaired or librarians, it would not be far off to equate font and point size."

"Very good, Ahn," Professor McIver interjected. "It is important to have an actual size when dealing with true VA, but that is only half the equation. What about the actual working distance, such as when someone records nVA as 10 point?"

"Not a problem; we just say, for example: 10 pt at 40 cm," Ahn proudly proclaimed. Now we have an actual working distance and an actual size. That makes the 'n' system better than RS, right?"

"Indeed, it does, Ahn," Professor McIver said, "but how does one record that to make comparison with dVA easy and quick, especially when you mix metric and imperial systems?"

"Oh," Ahn pondered. "I see what you mean. Creating a Snellen fraction would be awkward at best."

"Not to worry," Professor McIver assured him. "At least with an actual working distance and actual an size of the letter, we can eventually extrapolate a psychometrically valid nVA. For now, know that any 'n' measurement must also be recorded with the working distance.

"On to the J-system," Professor McIver said. "Jesse Johnson, I hear you are an advocate of using the J-system for nVA. Would you please explain to the group why you find it so compelling?"

"I got this," Jesse eagerly exclaimed, "but just call me J.J., please. "Jaeger has been used all over the world since the mid-19th century. Developed in 1867, originally a set of paragraphs of variable size. Nowadays, it is usually seen on a near-point card with single letters. All the surgeons I know use it, and electronic health records frequently have it in drop-down menus. That gives J-system the advantages of widespread use over many years."

"Nicely stated, J.J." Professor McIver complimented. "It is indeed a commonly used nVA system that has been around a very long time. Before I begin my critique of the Jaeger system, do any of your classmates wish to chime in?"

"Yes, I would." Ahn interjected. "Much like the point system, just because a test has been around a long time does not mean it is valid or reliable."

Rochelle then jumped in with, "And I do not see any working distance recorded when any J number is recorded, like J1 or J2, and so on."

"Excellent, both of you!" Professor McIver asserted. "In addition, J size is not standardized between chart manufacturers, and there is no accounting for letter readability or stroke height commonality for letters that go above or below the line of text, so even if one records the working distance of a J nVA, one is unable to record a Snellen fraction with an actual letter size because the size is not known. Therefore, the J-system is useless for someone interested in test task equivalence or psychometric integrity."

"But why do so many people use the J-system in practice then?" J.J. asked, exasperated.

"For that answer," Professor McIver replied, "one has to look at psychosocial reasons, not psychometric ones. Think back to when we discussed 'The Source'. Recall the levels of confidence we have in each stage of evidence and the weight we assign to them. Also, recognize that the amount of material students and interns/residents must absorb inhibits them from drilling down to the foundation of each bit of new knowledge. Professors with stellar credentials and great respect for their work hold forth on the subjects of their expertise, and interns/residents memorize what they are told. Some of those interns/residents then go on to distinguished careers of their own and teach their students what they learned from their mentors, and so on, from generation to generation."

"But that is not the scientific method," Rochelle interjected, stating the thoughts of each of the students in the group. "It is more like quackery, methodology where one does not test the claims of the proponent."[9]

"Absolutely," Professor McIver agreed. "Quackery is a methodology that places the burden of proof on the skeptic, not the proponent, which is the exact opposite of the scientific method. You see its use much too often in crazy theories on the internet, which subsume the naive with what sounds like science. But, in fairness to the busy intern or resident in health care, there is not always enough time in the moment to fully test all the pronouncements of the sages. Still, we need to take the time to think critically and test the common canons we use on a regular basis. Regarding the three ways we have looked at so far for measuring and recording nVA, specifically reduced Snellen, the point system, and Jaeger, we find that they are all incomplete and potentially misleading. Clearly, they do not meet the standards that our psychometric integrity demands, nor do they allow us confidence in test task equivalence."

"Logan, may I ask you to tell us about the fourth system of measuring and recording nVA with its advantages and disadvantages?" Professor McIver said, turning to the fourth student in the group.

"Of course," Logan replied. "I must say that I love the M-Unit system. It uses letters with an actual size. By definition, a 1 M letter subtends 5 minutes of arc at 1 meter. Since it is metric, we can set up a rational Snellen fraction with the test distance in meters over the M letter size. This allows us to compare nVA with dVA to see if the results make sense. Also, the letters have been chosen for equivalent readability, further enhancing our level of confidence in the results."

"That sounds like the M-Unit system is a slam-dunk for becoming the standard for measuring and recording nVA," Professor McIver stated, "but are there any drawbacks to the M-Unit system?"

"None that I can see," Logan smugly replied. "It is clearly the best psychometric system for measuring and recording nVA."

"Hold on," J.J. cautioned after a thoughtful pause. "I learned today that psychometric advantage is not always what drives people, even the smartest ones. Psychosocial forces are powerful determinants of behavior and can at times override the scientific factors. While now I see that in a logical world, the standard for nVA would clearly be the M-Unit system, it is not used commonly in practice. Contemplating why it is not the worldwide standard leads me to believe that the inertia and habit of the psychosocial domain when using the other three nVA systems inhibits the widespread use of the most rational and soundest system in psychometric terms, M-Units."

"Well thought out and well stated, J.J.," Professor McIver congratulated. "Therefore, in order to break fully from what we have established are the inadequate and misleading nVA systems of reduced Snellen, the point system, and Jaeger, going forward, we will henceforth always record nVA in a Snellen fraction, with the numerator being the actual test distance in meters and the denominator as the actual size of the smallest letter read in M-Units. Further along, we will learn how to use logMAR thinking to convert imperial measurements to metric and create Snellen fractions for reduced Snellen and point measurements, as long as they are recorded with test distance."

Down for the Count

"The problem is never how to get new, innovative thoughts into your mind, but how to get the old ones out."
–Dee Hock

"Okay, Hugh," Professor McIver began the session, "having established that visual acuity exams were arbitrarily developed based on an employment test for apprentice astronomers hundreds of years ago, are you ready to delve into logMAR thinking and expand your practice horizons?"

"Actually, Professor McIver, I would like to hand this off to my classmate with the long name; we just call him Einstein as he seems to get things earlier than most of us. He is the one in our class who actually believes that this 'logMAR' thinking paradigm of yours might be promising."

Turning to the student nicknamed Einstein, Professor McIver quipped, "I am pleasantly surprised to hear that. Almost everyone who first hears of logMAR thinking initially has their eyes glaze over in flashbacks to high school math class, where logarithms initially confounded them before they slowly backed away to hide. Do please tell me why you think it has potential."

"Sure, it's pretty simple really: I just hate memorizing formulas and heard that this logMAR thinking is just about counting steps without having to memorize much. That's about it. I like things simple."

"You know, I don't like memorizing formulae either," Professor McIver said, smiling, "and the original Einstein is purported to have said not to memorize anything you could look up, and that is exactly what logMAR thinking is about: minimal memorizing and maximum impact. In fact, that is how the title of this little book came about! Low vision success with minimal memorizing; it's so Einsteinian.

"Now, if you can remember just a few simple principles and can count to ten, you too can be as successful with patients who have partial vision as you are with fully sighted patients. Let's start counting."

"Reviewing 'The Source' quickly," Professor McIver eagerly said, "we already know good sight has been arbitrarily though not unreasonably described as the ability to just recognize a letter that subtends a minimum angle of resolution of 1′ arc. Also, Weber showed us that human sensory ability to detect change is a log progression of 0.1 log steps. Putting those two principles together is what Ian Bailey and Jan Lovie-Kitchin did to create the first rational visual acuity chart, the Bailey-Lovie Chart. Let's build one here to lock in those principles, and once we have that, we can proceed to unlock the power of logMAR thinking. I need another student to assist me. You, what is your name?"

"Well sir, my name is Edward Neville, but people just call me E. N."

"Makes sense," Professor McIver acknowledged. "If you are 'down for the count', we are going to begin at the beginning to build our logMAR chart; it really is a calculator just like slide rules of old in that one can do more complex math by just counting steps. Recalling that our starting point of good sight will be an MAR of 1′ arc, and its attendant VA of 20/20, what is the log of the MAR?"

"Easy start," exclaimed E. N., "High school math says that the log of 1 would be zero!"

"Always good to start easy," Professor McIver smiled. "Now, knowing what Weber discovered, what would be the next reasonable size letter as a JND larger than 20/20's MAR of 1′ arc?"

"Weber's Law says that a 0.1 log increase in size would yield a JND, and that would mean that starting from 20/20's logMAR of 0.0, we would add 0.1, which then equals 0.1 total. If we take the anti-log of 0.1, we get an MAR of ~1.25, and that yields a VA of 20/25," E. N. said confidently. That fits perfectly with our vision charts for fully sighted patients, so no big deal, right?"

"Perhaps," countered Professor McIver, "it's no big deal…yet. Let's keep building our logMAR chart/calculator. What is the next JND step, E. N.?"

"Let's do a bunch at once," E. N. suggested. "We would climb the logMAR scale 0.1 steps at a time, so: 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, and 1.0. Taking their anti-logs gives us their MAR: 1.6, 2.0, 2.5, 3.2, 4.0, 5.0, 6.3, 8.0, and 10.

We can translate the MAR into visual acuity by putting '20' in the numerator and multiplying the MAR by 20, then inserting it into the denominator, like so: 20/32, 20/40, 20/50, 20/63, 20/80, 20/100, 20/125, 20/160 and 20/200."

"My name is Phoebe, and oh, my gosh!" she exclaimed. "I thought this logMAR thinking system was supposed to make low vision easier, and all I see is a lot of crisscrossing numbers that make my head spin."

"Hang on, Phoebe," Professor McIver interjected, "we just have to get past this hump to show why logMAR is so powerful, then we can begin using the paradigm to make clinical measures easier. Let's see if we can make a vertical table out of our numbers above to indicate how the logMAR chart/calculator can be used."

"I see it easier now," Phoebe began, "but it still just looks like a bunch of numbers on a regular acuity chart."

"They are!" Professor McIver said excitedly. "But because they are derived from Weber's Law, they have

LogMAR	MAR	VA
0.0	1.0	20/20
0.1	1.25	20/25
0.2	1.6	20/32
0.3	2.0	20/40
0.4	2.5	20/50
0.5	3.2	20/63
0.6	4.0	20/80
0.7	5.0	20/100
0.8	6.3	20/125
0.9	8.0	20/160
1.0	10.0	20/200
1.1	12.5	20/250
1.2	16.0	20/320
1.3	20.0	20/400

tremendous power if we just notice a few things and memorize a few constants. Then we can introduce predictive analysis and make clinical work easier. Remember that every single line or step is a just-noticeable difference, or JND, so every line is a level of significance different than the one above or below. That extends not just to visual acuity, but to dioptric power and telescopic power as well. A JND is a JND is a JND."

"Wait," E. N. said slowly, "I think I see a pattern…it seems that in the VA column, every three steps down, the denominator doubles. Oh, and same thing in the MAR column! But the numbers aren't exact sometimes. The 32 doubles to 63 and the 63 to 125."

"Yes, E. N., correct on both counts. The first is one of the few things I want you to memorize," Professor McIver commented. "Let's visualize that in the columns of our chart, starting with 20/20 and dropping down three lines, or JND steps. You can see that we land on 20/40. Three more lines/steps down, and we are at 20/80, then 20/160. I want you to memorize that: on a logMAR chart, every three steps either doubles or halves the value of the denominator, depending on the direction you go. The same pattern exists in the MAR column. Here it is highlighted to make it more visible. Regarding your second observation, E.N., for those cases that are not exact, it is because of rounding extra and unneeded digits to make the concept easier to use in clinic without affecting significance of the JND."

"You may recall me saying something about being able to count to ten." Professor McIver continued. "Well, you might also notice on the chart that not only does every three steps double or halve, but every ten

LogMAR	MAR	VA
0	1	20/20
0.1	**1.25**	20/25
0.2	1.6	20/32
0.3	2.0	20/40
0.4	**2.5**	20/50
0.5	3.2	20/63
0.6	4.0	20/80
0.7	**5.0**	20/100
0.8	6.3	20/125
0.9	8.0	20/160
1.0	**10.0**	20/200
1.1	12.5	20/250
1.2	16.0	20/320
1.3	20.0	20/400

steps move the decimal one place. This means that if you ever have to use the logMAR scale and it goes off the available numbers on the chart, you can just move the decimal to continue. We will work on that more later, but for now, memorize that ten steps move the decimal place."

"I see what you are saying now, but what good is it in practice?" Phoebe asked.

"Excellent question, and an even better segue, Phoebe," Professor McIver began. "We know that the discovery of logarithms and the subsequent development of the slide rule led to the ability to do complex calculations easily, and an explosion in the

LogMAR	MAR	VA
0.0	1.0	20/20
0.1	1.25	20/25
0.2	1.6	20/32
0.3	2.0	20/40
0.4	2.5	20/50
0.5	3.2	20/63
0.6	4.0	20/80
0.7	5.0	20/100
0.8	6.3	20/125
0.9	8.0	20/160
1.0	10.0	20/200
1.1	12.5	20/250
1.2	16.0	20/320
1.3	20.0	20/400

sciences took place, from architecture to navigation to physics, chemistry, construction, and myriad other disciplines. A slide rule even went to the moon on the Apollo missions in the 1970s. Our logMAR charts are just like slide rules in that they allow quick and accurate calculations: in this case, knowing what a patient will see based on a single good measurement of visual acuity. I call it predictive analysis, and it is what gives logMAR thinking its clinical power."

"Sounds intriguing," E. N. began hesitatingly, "but if it is so powerful and has been around since the 1970s, why isn't it the standard of low vision care?"

Pausing a bit before answering, Professor McIver said, "I too have wondered that, E.N., and it wasn't until I applied the social thinking of punctuated equilibrium that an answer began coalescing in my mind. I think that logMAR processing was just too disruptive in that it required a substantial front loading to change paradigms before benefits would be visible, and people already in the field were satisfied with their own models while teaching them to their students. That is not to say that their ways were wrong or bad, but logMAR thinking allows more degrees of freedom, fewer assumptions, and makes formula-free practice possible. Whatever the reason for its non-dominant position today, I want to present to you predictive analysis and let you be the judge of its utility for when you are in practice. Let's begin."

"There are only four parts to predictive analysis:

1. Measure and record VA with actual letter size and actual test distance, using consistent units.
2. Set a VA goal for improvement to meet the patient's needs.
3. Count the steps on the logMAR chart between measured and goal.
4. Implement with working distance and dioptric power for near or telescope power for distance."

"Let's look at the parts one at a time in sequence," Professor McIver said. "First is measure and record VA. Sounds easy, right? But we have seen how inappropriate and sloppy measurements, and old but commonly used systems, can lead to psychometrically invalid results. In order to maximize the power of logMAR thinking properly, it is best to use M-Units for letter size and meters for test distance: actual letter size and actual test distance. Once we have a psychometrically valid visual acuity, we ask ourselves whether that is good enough for the patient's needs. If the answer is no, then we need to set a goal for the letter size that will meet the patient's needs. For our purposes here, we will be dealing with near point reading distances, though soon enough, we will see how the same principles can be applied to distance with telescopes. Always keep in mind that we are looking at JND steps on the logMAR charts."

"How about an example, Professor McIver?" Remi asked from the front of the room. "This sounds fascinating, but I don't see how to apply it."

"Great prompt, Remi," Professor McIver said. "Everyone get out their logMAR near point card and follow along. Ready? Okay, for part one of predictive analysis, let's say a patient wants to read regular size printed material, which we have already established as 1 M, but can only read 1.6 M size letter at 40 cm with their current +2.50 D add. We record the acuity as 0.4 m/1.6 M.

Now, part two: we ask with our inner voice, 'Is that good enough?' Since the patient has reduced visual acuity, the answer usually is of course not. For this example, let's set our goal at 1.0 M print size since that is what the patient expressed as their reading need.

Part three says that we count the JND steps between measured nVA and goal nVA, which in this case is two steps: 1.6 M the measured—>1.0 M the goal. Now comes the fun part of predictive analysis. Since we need two JNDs of improvement to get from the measured VA to the goal VA, we need two JNDs closer working distance and two JNDs of higher dioptric power."

"What do you mean about JNDs of working distance and dioptric power?" E. N. asked.

Professor McIver pointed to the logMAR chart/calculator and said, "Every step between lines is a JND, and it doesn't matter if the JND is an acuity, a working distance, or a dioptric power; a JND is a JND is a JND. When we want to improve acuity to a desired goal from the measured baseline, we have to reduce working distance and increase dioptric power by the same number of JNDs as is the number of steps from measured to goal. In our example above, we know the patient is reading at 40 cm. By finding 40 on the chart, we see two steps smaller for a closer working distance is 25 cm. So, we must move the chart to 25 cm for the patient to see it. However, since most of our low vision patients are presbyopic, we also need to adjust the add power upwards. The dioptric equivalent of the original working distance is 2.50 D. Making that higher by the two JND steps necessary takes us to 4.00 D. If you then put in a 4.00 D add and hold the chart at 25 cm, all other things being equal, the patient will be able to read 1.0 M. No calculations, no formula, no guessing; just using the slide rule-like power of the logMAR chart's progression unleashes the power of predictive analysis."

"That is so unexpectedly easy," Remi stated. "All we have to do is measure properly, set a goal, count the steps between measured and goal, then implement based on JND. Are you saying that now I can just use predictive analysis for my low vision patients and not be so nervous?"

"Yes, Remi, it is easy, but most people I have encountered over the years try to make it more difficult or think it is some kind of 'voodoo'," Professor McIver said. "Just a few simple steps takes you from current VA to goal-meeting without fuss. The key is to do the parts in order, and since there are only four parts, it is simple to remember."

"What about distance vision?" E. N. interjected. "Many patients with partial vision want to see better for travel, television, or other distance tasks like driving. How do we help them when distance is, by definition, zero diopters?"

"Great question, E. N." Professor McIver said, turning toward him. "The same principles apply, except instead of diopters, we use telescopic power or times (x). Follow me on this: when we have fully corrected a patient to their best distance visual acuity, what is the telescopic power in play? Anyone? Trick question, actually, as it involves the multiplicative identity of anything times one is itself. Therefore, our fully corrected patient in our exam chair is using their natural telescope power of 'one'. We still take best visual acuity with actual letter size and actual test distance, part one of predictive analysis, and if it is not good enough, we set a goal, which is part two, before counting the steps between our measurement acuity and goal acuity, that being our part three. Then, for part four, we implement it, but instead of starting at the working distance or diopters, we start at 1.0, which is the patient's incoming telescopic power, and count up the chart. Here is an example: a patient sees 20/100 but wants to see 20/40, the common visual acuity needed for obtaining a driver's license. From the logMAR chart/calculator, we see that it takes four JND steps to get from 20/100 to 20/40. Now, go to 1.0 on your logMAR chart/calculator and count up four steps: 1.0—>1.25—>1.6—>2.0—>2.5, and there it is, we need a 2.5 x telescope to get our example patient to see their goal. Again, no formulae, no calculations, no guessing and no voodoo. By the way, the most common error here is to mistake telescopic power of x for dioptric power or 'D'; don't fall into that trap."

"My goodness, Professor McIver, that is a lot to take in," Hugh slowly said. "No wonder it hasn't caught on."

"I get your point, Hugh," Professor McIver said understandingly. "But I believe that trying to memorize reams of formulae that have many assumptions built in is really the harder path. Once you recognize the power and simplicity of logMAR thinking and predictive analysis, and how they free you from formulae, calculating, and guessing, I think you will wonder how you practiced low vision without it. All you have to do is practice with predictive analysis and become familiar with it in order to appreciate its utility and power."

"That's it for now."

Another Added 'Bennettefit'

"Science advances by the relentless examination of the commonplace; that some of its greatest discoveries have been made through fascination with what other men have regarded as not worthy of note."

–Jules Henry

"Well, if it isn't Logan Mars," Professor McIver said, looking up from his desk during office hours. "Please come in. Is something on your mind?"

"Good afternoon, Professor McIver," Logan began. "I am intrigued by the applications of logMAR thinking and predictive analysis and see how they can rationalize my approach to low vision exams, but it seems there must be more to it. I mean, I see how to use the logMAR chart/calculator to quickly get the appropriate add to meet patient's reading goals and also to use it for choosing telescope power for distance, but not everyone uses M-Units or metric distances. What happens then?"

"Very good observation, Logan. I have planned that for today's lecture and workshop. Let's get to the lecture hall and address your questions with the whole class," Professor McIver said. "Walk with me."

"Logan brought a good question to me during office hours," Professor McIver said, opening class time. "He is interested in going beyond the basics of logMAR thinking and predictive analysis, especially regarding non-metric measurements such as reduced Snellen acuity measurements or the 'n' (point) system. Let's jump in. First, there are another few things for you to memorize."

"Wait, Professor McIver, you said we didn't have to memorize stuff with LogMAR thinking," protested Karen. "Now you say we need to memorize more. That sounds like a bait and switch."

"Karen, what I said was you don't have to memorize as much," countered Professor McIver. "Besides, it is on the logMAR near chart/calculator if you forget something, so memorizing just helps you along but is not essential. Let's look at what I mean. Everyone, pull out your handy near logMAR chart and note what it says at the top: 16 inches or 40 cm. Now notice that those are numbers on the chart that are four steps apart. Now you can easily transpose inches to cm as they are a constant ratio like the logMAR chart/calculator! Since the number of cm is always larger than the number of inches for the same distance, you always know which way to go on the logMAR chart. For instance, 10 inches is 25 cm. Therefore, if someone tells you they measured a near acuity at 10 inches, you know the numerator of the reduced Snellen fraction is 0.25 m."

"That is useful, alright," Karen conceded, "but that only gets us the numerator. What about the denominator in cases where the reported near visual acuity is in reduced Snellen or point?"

"Let's solve for that now!" Professor McIver exclaimed, happy for the lead-in to the next part. "look at your near point logMAR chart and find the 1.0 M size row. Got it? Ok, now look across the row, and you should see 20/50. If someone reports a reduced Snellen acuity of 20/50, you know the letter size was 1.0 M; that is your denominator. Now, hopefully, they also record a working distance. If that is 40 cm, then your actual psychometrically accurate reduced Snellen fraction would be: 0.4 m/1.0 M. If, however, the working distance is reported as 10 inches, you can quickly count up four steps to 25 cm and record the VA as: 0.25 m/1.0 M."

"Now, the point system uses an actual size (1 pt = 1/72 inch), and you have to memorize this: 8 pt = 1.0 M, but once you have that, you can see they are only separated by a single step with a decimal place moved. To transpose from point to M-Units, you just go one step up the chart and move the decimal to the left. Also, you recall from above that since 1.0 M = 20/50 (on a standard logMAR near chart), then 8 pt = 1.0 M = 20/50; another of the few things useful to memorize.

"So, if a near acuity is reported as being 20/100 at 10 inches, in the past you might have been flummoxed as to what the near visual acuity actually is, but now, using those minimal memorized factors and the power of the logMAR chart/calculator, you can determine the actual working distance as 25 cm and the actual size as 2.0 M, giving you a psychometrically valid reduced Snellen fraction of 0.25 m/2.0 M."

"Is that all you can do with logMAR thinking and predictive analysis?" came the smart aleck anonymous voice from the back of the classroom.

"While sarcasm has not incorrectly been described as an example of intelligence poorly used," Professor McIver retorted, "there is another useful bit of logMAR magic you might find charming. In my travels, it has come in quite handy. Specifically, one can translate miles to kilometers and back, as they are separated by only two steps on the logMAR chart/calculator; i.e., 100 km = 63 miles or 40 kilometers = 25 miles. This is especially good to know when one has a speed limit to mind in a foreign land."

"Is that it?" came the plaintive voice again. "Is that all that you have for us?"

"As a matter of fact, no, there is another added logMAR 'Bennettefit' that is something you might find much more useful in clinical practice than just miles to kilometers and back," Professor McIver again countered. "Reciprocals of diopters and meters are built into our logMAR chart/calculator. Once again, take another look at your near point logMAR chart/calculator and find the 1.0 M. Got it? Okay, now go one step up to find 1.25 and one step down from 1.0 to find 0.8; those are reciprocals. 8.00 D focuses at 12.5 cm, and 1.25 D focuses at 80 cm. Now, return to 1.0 and count three steps up from there to find 2.0, then three steps down from 1.0 to see 0.5: 5.00 D focuses at 20 cm and 2.00 D focuses at 50 cm. Quickly you can see that reciprocals are symmetric about 1.0! No more

"That's enough added 'Bennettefits' for today," Professor McIver said, glancing at the back of the room for any more questions on the power of logMAR thinking or the logMAR chart/calculator. "Okay, if there's nothing else, dismissed."

References

7. McAllister B, Spors F. Physiologic analogues to the slide rule with applications in predictive analysis and assessment of human vision. 2018, Available from: https:// osgalleries.org/journal/ displayarticle.cgi?match=27.2/V27.2P44.pdf. Last Accessed May 22, 2026.
8. Slide rule history. Oughtred Society. n.d., Available from: https:// www.oughtred.org/ history.shtml. Last Accessed May 22, 2026.
9. Cocker R. Distinguishing science and pseudoscience. May 30, 2001, Quackwatch. Available from: https://quackwatch.org/ related/pseudo. Last Accessed May 22, 2026.

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McAllister B. Clinical guide to Einsteinian low vision rehabilitation—Part 2 of 4. Optom Vis Perf 2026;14(1):159-69.