Accentuate the Negative

Finding the Error in Your Patient's Ways May be the Key to Their Neurorehab Success

By Jeff Berger, MPT
Cracchiolo Inpatient Rehabilitation Center
St. John Hospital & Medical Center

"A person who makes few mistakes makes little progress." These words by American author and aphorist Bryant McGill describe quite simply an emerging paradigm that is proving successful in the realm of neurorehabilitation – the paradigm of error augmentation.

The goal of improved motor function seems most attainable for neurorehab patients today when physical and occupational therapists employ interventions that are grounded in motor learning principles. Motor learning, or the process of developing or changing motor skills through practice and experience, can be enhanced if therapists create training scenarios that challenge patients to adapt their motor activity. Error augmentation, by increasing asymmetries and movement errors that patients must then adapt to, provides therapists inroads to connecting with a patient's central nervous system, facilitating neuroplastic cortical change.

I had my first real taste of error augmentation at a continuing education course at The Rehabilitation of Chicago (R.I.C.) several years ago. It was at this course that I had the opportunity to interact with T. George Hornby, PT, PhD and Jennifer Moore, MPT, NCS, DHS, both experts in the field of locomotor retraining. At the course I was able to take a walk on a split-belt treadmill and experience true motor adaptation. When a person walks on a treadmill with each leg moving at a different speed, there is a quick accommodation that occurs as the faster leg spends less time in stance phase and the stride for that leg lengthens. Once the belts are returned to the same speed, there is a period of time when the person continues to walk with the adapted pattern. When a patient with an asymmetric step length (characteristic of a hemiparetic gait pattern) is trained on the split-belt with the short stride leg moving faster, the motor adaptation that occurs can help to correct the asymmetry. At the time I attended the course at R.I.C., most of the research linking split-belt treadmill training to locomotor adaptation for stroke survivors hadn't been published yet, but the course sparked a new understanding for me of the potential that this technology could have for neurorehab patients. The vision for our own gait lab was born.

Not long after the course at R.I.C., St. John Northshores Hospital, where I worked on the inpatient rehabilitation unit, was closed and the entire unit was moved to our health system's medical center campus in Detroit. The move, which was made possible in large part through a generous donation from a former patient's family, was an opportunity to design a rehab unit from the ground up and update our equipment

and rehab technologies. Development of a gait laboratory was an important element of the Cracchiolo Inpatient Rehabilitation Center project, and today the lab has been up and running for over two years.

The two centerpieces of the St. John Hospital & Medical Center (SJH&MC) Gait Laboratory are our Woodway split-belt treadmill and our Aretech ZeroG-Lite treadmill-based gait training system. The Woodway split-belt treadmill allows our therapists to adapt patient walking patterns through error augmentation and the ZeroG-Lite provides dynamic body-weight support allowing for early and intensive gait training interventions. The ZeroG-Lite system has given me confidence that I can aggressively challenge patients with error augmentation techniques with complete safety. Joe Hidler, PhD, developer of the ZeroG body-weight support system and veteran researcher, was instrumental in helping to design our lab and we are grateful for his experience and insight. As clinical application of error augmentation requires a therapist to first analyze a patient's movement patterns to identify asymmetries and errors, we have recently added the Simi Aktisys Reality Motion System to our lab technologies. The Simi system software, capable of analyzing patient locomotion from different camera angles, allows us to detect even subtle gait asymmetries and then determine if our gait training interventions are having a genuine impact in terms of changing a patient's walking pattern.

Even before the SJH&MC Gait Laboratory opened its doors, we had been employing error augmentation techniques with success for neurorehab patients with a variety of diagnoses including CVA, TBI, incomplete spinal cord injury, MS and Parkinson's disease. I have even had success treating gait asymmetries resulting from orthopedic impairments. The dramatic changes that we have been able to make with patient motor control over the past few years have fueled our team's fire and compelled us to take error augmentation to a whole new level.

Use of the split-belt feature on our Woodway treadmill to correct step length asymmetries is only the first level of error augmentation we employ when working to adapt patient walking patterns. If patients have excessive internal or external rotation in one or both of their legs when walking, we'll spiral resistance bands around the culprit legs to augment the impairment. If a patient walks with a "scissoring" pattern, we'll use bands to pull the limbs even further into an adducted "scissor" alignment. For patients who demonstrate asymmetry in their weight bearing posture and lean to one side, we'll use bands to pull the trunk or pelvis even further to that side. When a patient walks with a flexed posture, we'll employ a figure 8 strap around the patient's shoulders and attach bands to the front of the strap to accentuate the flexion posture. These error augmentation strategies heighten patient knowledge of gait deficits and set the stage for motor adaptation and neuroplastic change.

An article published in *Physical Therapy* this past September investigated patient perception of spatiotemporal gait asymmetries poststroke. The researchers concluded that there may be a threshold of error that patients must experience before they are consciously aware of their gait asymmetries and that this awareness may be important for motor learning and long-term correction. This conclusion supports our use of multilayered error augmentation and has helped us to see that we may be on the right track in challenging our patients with such intensity.

In our continued pursuit of optimizing patient walking outcomes, we are investigating adding technologies such as the Zeno or GAITRite walkway and APDM Mobility Lab wearable sensors which will integrate with Aretech's ZeroG-Lite BWS treadmill. The walkway systems provide data on gait parameters such as step length, step width, stance time and toe in/out angles and would allow us to determine if the outcomes of patient error augmentation treadmill training are translating to over ground walking. Wearable gait sensors can provide the same types of data on walking function but would allow us to collect real-time data and perform gait and mobility analyses with patients outside of the hospital or clinic.

Along with gait rehabilitation we have also begun to employ error augmentation techniques to improve patient motor control with functional activities such as sit-to-stand transfers and upper extremity reaching. After attending the 2015 Combined Sections Meeting, and hearing a presentation on hemispheric specialization and upper extremity control mechanisms by Robert Sainburg, PhD, I now have an even better idea of how our rehab team can apply error augmentation techniques to improve reaching ability and upper extremity function. We are also fortunate to have technologies such as the Motorika ReoGo system and the Saebo ReJoyce workstation that combine robotic technologies with virtual reality interaction. These technologies give patients real-time feedback when it comes to error and allow us to design optimal motor learning training experiences for our neurorehab patients.

In looking toward the future for our neurorehab program here at St. John Hospital & Medical Center we hope to throw our own hat into the clinical research ring and investigate further the use of error augmentation in optimizing motor learning outcomes. The technologies outlined in this article allow our therapy team to analyze patient movement patterns, maximize adaptable errors and then objectively measure the effectiveness of our treatment approaches. I would encourage therapists working in neurorehab to trial error augmentation techniques in their own clinical settings and perhaps add to the clinical evidence base for this intervention strategy. There is power in patient perception of error and asymmetry, so my parting advice for employing error augmentation interventions would be to find the error in your patient's ways and accentuate the negative.

References

1. Wutzke CJ, Faldowski RA, Lewek MD. Individuals poststroke do not perceive their spatiotemporal gait asymmetries as abnormal. *Physical Therapy*. 2015;95(9):1244-53.