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DEPARTMENTS

Letters to the Editor

Effectiveness, Usability, and Cost-Benefit of a Virtual Reality—Based Telerehabilitation Program for Balance Recovery After Stroke: A Randomized Controlled Trial

I have concerns about the level of detail provided regarding the design of visual feedback and exercise in the article by Llorens et al[1] featured in the March issue of the *Archives*. I was excited to see an article about interactivity in the *Archives*, an area of study that has been called "interactive neurorehabilitation therapies"[2].

The lack of sufficient information makes it difficult to interpret or cite this article appropriately. In addition, I am concerned that the article is categorized as a randomized controlled trial (RCT) when it does not seem to meet the definition.

This study randomized participants with stroke into 2 groups. The one difference between the 2 groups was in the place where the virtual reality (VR)—based training component was delivered: home or clinic. Both groups received an experimental treatment thrice a week: a VR application designed to treat balance. And both groups received a physical therapy regimen twice a week, which was intended to complement motor control but not train balance. The VR scheme for advancing difficulty and exercises provided were equivalent in both groups. The authors found comparable differences in Berg Balance Scale scores between both groups postintervention and call the study an RCT in the title.

First, the information on visual feedback provided through the VR application is insufficient; some designs promote change better than others,[3] and so without more information on the visual feedback provided, the reader cannot draw conclusions or compare results with those of other existing studies.

Second, exercise design during the VR intervention is not sufficiently reported. Previous research has revealed that two-legged exercises coaching equal distribution of weight through some forms of visual feedback promote balance gains,[3] but less is known about interactivity in combination with unilateral balance exercises. More detail about the type of exercises led by the VR application should have been disclosed so that the reader can assess whether the study reproduces previous findings or breaks new ground.

Third, the authors do not sufficiently report on the physical therapy (PT) activity that occurred in addition to the VR application. Any weight-bearing activity requires balance skill; therefore, as stated, PT sessions that train skills "not related to balance to complement motor training" would theoretically have been limited to non—weight-bearing activity. As shown in another article[4] featured in the March issue of the *Archives*, motor control—based interventions are capable of successfully improving locomotor skill, of which balance function is a component. Participants in the VR study could have theoretically improved from the motor control—based PT alone, with no added value provided by the VR-based training.

Fourth, the title describes the study as an RCT, but it does not seem to meet the definition, given that all participants received an experimental intervention and no randomly assigned group of participants received a known, nonexperimental intervention as a comparison.

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Disclosures: none.

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The Authors Respond

We thank our colleague for the interest in our article[1] and the editors for the chance to clarify the text.

First, we agree that the limitation of the length of the article could have resulted in insufficient information on visual feedback. In essence, the virtual environment (VE) consisted of a checkered floor whose center was indicated by a darkened circle as well as jelly items that appear from the ground around the circle (figure 1). The VE was represented from an overhead and slightly backward one-point perspective to allow users to perceive their peripersonal space in all directions. The position of the user's feet were

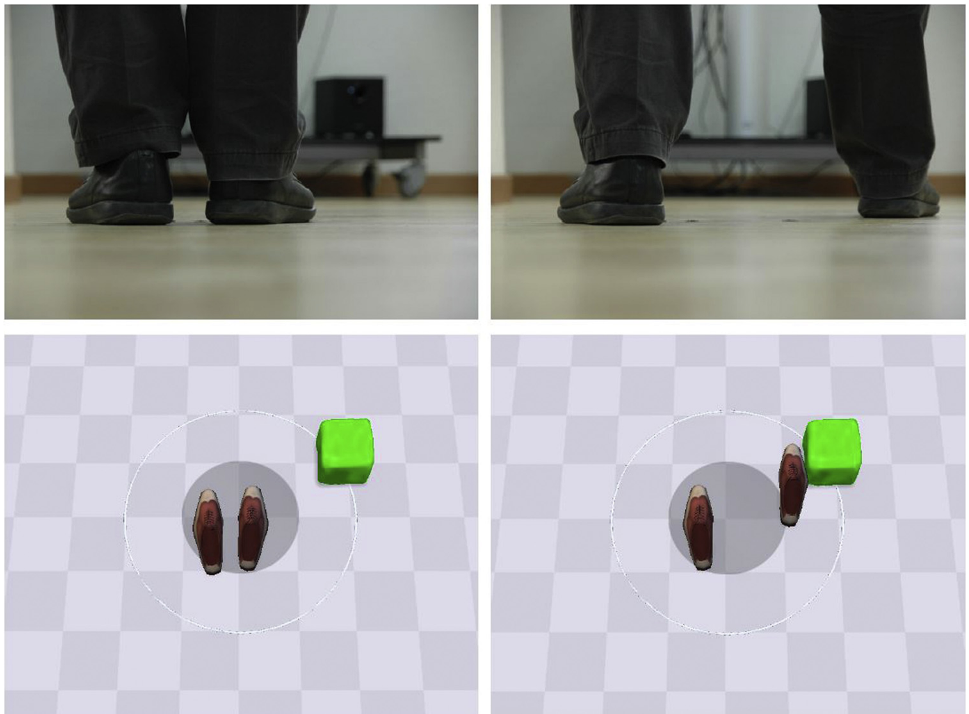

Fig 1 VE of the stepping exercise. The figure shows an example of a stepping movement (bottom row) and the feedback provided by the VR-based system (top row).

represented by two virtual shoes with a third person view. As stated, the goal of the exercise was to reach the items with the nearest feet while maintaining the supporting foot within the circle. After reaching the item, the extended extremity had to be brought closer to the body within the boundaries of the circle (some arrows indicated this requirement in the VE). Otherwise, the exercise did not allow new items to be reached (the feet turned red).

Visual feedback is a well-known key aspect for motor learning, particularly after stroke.[2] However, the article referred by our colleagues does not determine that "some designs promote change better than others" but how feedback affects postural control. Useful conclusions about the effects of force platform feedback on balance training after stroke can be drawn from a Cochrane review.[3] In addition, the referred article studies the effect of visual feedback on the use of ankle and hip strategies in a young healthy population. In contrast, our study focused on the use of the stepping strategy (which goes beyond unilateral balance training) to improve balance in the population with stroke,[1] limiting extrapolation of the results. We kindly refer our colleagues to a previous study of our group[4] in which a virtual reality (VR)—based system equipped with a force platform was employed to improve balance in a stroke group through the use of ankle and hip strategies with promising results.

Second, as stated in the text, all the participants were trained in skills not related to balance twice a week to complement the VR-based balance training. These sessions mostly focused on upper-limb training, including active and assisted movements, joint mobilization, muscle toning, strengthening, sensory retraining (using the Perfetti method), and fine manual dexterity exercises. Hence, participants did not train in balance-related skills during the complementary sessions, assuring that improvements in balance were promoted by the VR-based intervention.

Third, a controlled trial treats all the participants the same regardless of their group except for a factor that is unique to that group, usually the intervention. However, it does not imply that a group undergoes a conventional or placebo intervention. The alternative condition is determined by the objectives of the study. In this particular case, we had already determined the effectiveness of the VR-based intervention in comparison to a conventional physical therapy program.[5]

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It Is Time for Bowel-Omics

In the May issue of *Archives*, Adriaansen et al[1] describe bowel management outcomes in individuals living with spinal cord injury (SCI). Despite being a multicenter study of over 250 individuals, their approach suffers from limitations similar to those of other recently published studies (including Burns[2] and colleagues). The authors' use of the International SCI Bowel Function Basic Data Set and a single item on satisfaction with bowel management offers a limited view of the multifactorial issues facing patients with chronic SCI. Their finding that only 14% of participants were dissatisfied with their bowel management underrepresents the challenges; as they point out, more longitudinal research is necessary to provide insight to improve practices.

Patient surveys have consistently identified constipation, incontinence, and perianal problems as having significant detrimental impacts on quality of life. A systematic review of 24 studies on quality of life after SCI identified improved bowel function as a top priority.[3] At the same time, clinical research data to improve bowel management have consistently been found lacking. Coggrave et al[4] reviewed 20 trials of bowel management strategies and found that "available evidence is almost uniformly of low methodological quality."[4(p2)]

An ongoing research challenge is that the process of bowel management is arguably more multifactorial than any other physiological consequence of SCI. In addition to demographic factors and features of a patient's injury, it is affected by numerous behavioral and environmental factors (appendix 1). Despite being highly multivariate, research has studied aspects of bowel management in a univariate manner, hoping to control for a small set of other factors. On the other hand, results of bowel management are observed frequently and concurrently—in particular, the nature, quantity, and timing of stool.

A big data or omics approach is well-suited to unraveling the diverse cofactors and endpoints associated with bowel management. More importantly, a collection of more variables on more subjects could finally provide definitive data on ongoing questions and would likely enable identification of new associations, patterns, and other more personalized insights. Examples of using social media or handheld devices to capture high-frequency diary information directly from patients for big data analysis already exist. In 1 study, patients with epilepsy logged 70,990 entries on seizures.[5] Imagine having a database of 70,000 patient-reported bowel events.

Standard bowel data sets should be expanded to take advantage of new data capture technologies. For example, in inflammatory bowel disease, fecal volatile organic compounds were studied by an electronic nose, and profiles of patients were found to differ from healthy controls.[6] A mobile phone camera has been used for microscopy to analyze stool samples.[7] Global Positioning Systems have been studied to assess physical activity in various patient populations.

Although usability, data quality, and privacy concerns will need to be addressed, a big data approach to the study of bowel management appears immediately feasible. Development and distribution of the necessary software would likely be low cost. This type of application would be primed for rapid adoption and could catapult rehabilitation science forward.

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Disclosures: Sorani reports a financial relationship with Genentech, outside the submitted work.

Appendix 1 Illustration of an omics approach to the multifactorial nature of bowel management

Demographics	Behaviors	Environment	Endpoints
Age	Diet	Temperature	Stool frequency
Sex	Fluid intake	Altitude	Stool volume
Weight	Medication	Humidity	Stool type
Height	Exercise	Living arrangement	Predictability
Time since injury	Sleep	Cohabitants	Perianal problems
Injury level	Bowel procedure	Second-hand smoke	Pain

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