NEUROLOGICAL DISORDERS & EPILEPSY JOURNAL Open Access

SCIENTIFIC LITERATURE

REVIEW ARTICLE

Neurogenic Speech Disorders Rehabilitation: A Dosage Quest

Maria Claudia Franca and Valerie Elise Boyer*

Communication Disorders and Sciences Rehabilitation Institute, Southern Illinois University, USA

ARTICLE INFO

Article history:
Received: 15 July 2017
Accepted: 09 October 2017
Published: 18 October 2017

Keywords:
Neurospeech;
Neuroplasticity;
Dysarthrias;
SLP;
SOs

Citing this article: Franca MC, Boyer VE. Neurogenic Speech Disorders Rehabilitation: A Dosage Quest. Neurol Disord Epilepsy J. 2017; 1(1):112.

Correspondence:
Valerie Elise Boyer, Communication Disorders and Sciences Rehabilitation Institute, Southern Illinois University, USA, Email: valboyer@siu.edu

ABSTRACT

In neurospeech rehabilitation, compensation for loss of function takes place through reorganization and renovation of neural connections over repeated practice. Rehabilitation of motor speech skill lost to brain damage entails neuroplasticity, the brain's capacity to remodel itself as a response to training. A critical point in neurospeech treatment protocol involves exercising quantification, translated as frequency and duration of sessions as well as actual number of task repetitions, which seems to be a key aspect in achieving optimal therapeutic results. Quantification of exercising in speech-language-pathology should be as clear and precise as it happens for example with pharmacological prescription. Treatment efficacy ought to be based on specific considerations for suitability instead of a wide range of general methods, avoiding an 'one-size-fits-all' approach. This introductory discussion underlines the need of team work in the application of systematic procedures leading to optimal intervention choices.A combination of clinical outcomes with empirical evidence from experimental investigations may be most feasible through a collaborative effort between clinical facilities and research institutions.

Introduction

The power of communication is demonstrated at all levels in every day talks, professional exchanges, telephone and electronic-based conversations, public address systems, and chats among friends. The most important tool of human interaction is the ability of exchanging thoughts and ideas by oral means. Despite technology advances and alternative methods, nothing can replace human oral expression for transferring knowledge [1,2].

Negative effects of speech abnormalities include physical and emotional problems that may result in socioeconomic disadvantages [3]. Ultimately, unclear speech canaffect the ability to transmit messages effectively leading to struggles that influence quality of life. All persons should be able to express themselves, to create, and to disseminate their work regardless of differences or challenges in performance [4].

Speech Intelligibility

Speech intelligibility is an indication of comprehensibility within an orally transmitted message. This skill is frequently affected in neurospeech disorders, termed as dysarthrias [5]. In neurologically-based speech dysfunction, complete remediation and recovery of optimal speech is not always attainable. Nevertheless, functional communication should be the goal. This means interaction flowing, ensuring communicative exchange.

Optimization of speech through training is sustained by purposeful communication and reinforced by natural opportunities, valued by the individual [6,7]. As such, clinicians should keepfunctional objectives and social inclusion at the forefront in neurospeech clinical rationale. This includes goals achievable through workable procedures, well connected with physiologic components.

Neuroplasticity

Plasticity, or neuroplasticity, is defined as the brain's capacity to remodel itself as a response to training [8]. Brain's function and structure can be changed through biochemical and intercellular alterations, as well as via behavioral methods. This occurs at several levels of the nervous system, in addition to the cerebral cortex [9]. Commonly associated with young age, it can be also verified in mature individuals [6].

Rehabilitation of motor speech skill lost to brain damage entails neural adaptation associated with natural genetic and biochemical aspects, independent from voluntary actions; other changes have been identified with cognitive elements as well as with behavioral training [10,11]. This allows enhanced muscle activity, since motor skill is supported by increased neuronal firing and the recruitment of underused neural components [12]. Thus, compensation for loss of function takes place through reorganization and renovation of neurologic connections [13].

Successful outcomes in speech rehabilitation have been associated with exercising [8]. Repeated practices can promote neurogenic connections, leading to longstanding changes in the motor system, especially when it relates to purposeful actions [14,15]. Apparently, brain functional skills have dynamic characteristics, revealing continuous possibilities of modification and adjustment by experience. This seems to be particularly accentuated with implementation of voluntary use of affected physiological components with functional meaning. [10,15].

Exercising as a Brain Modification Agent

In spite of general recommendations regarding exercising broad benefits, there is still a need of more clear evidence of its efficacy in neurogenic based conditions [16]. In fact, causal relationships are not yet well understood, which limits estimations of half-life of training, as it happens in pharmacological prescriptions for example [14]. This contributes to make quantification imprecise and sometimes inaccurate [28].

Neurospeech rehabilitation practices are task-oriented, designed to target remediation of specific motor skills [17]. This is accomplished using multiple principles of neuroplasticity associated with effective practice, including persistent application and relevance of the targeted movement in the individual's routine [8,13]. In rehabilitation, neuroplasticity-related alterations are achieved through intensive training/retraining of the neuromuscular system, leading to structural and functional changes [18-20]. Moreover, effective task training should also involve continuously challenging goals, building on previous gains [5,6,21].

Drill

Repetitive and systematic speech practice observing specifically selected target and exercises, also called drill, is essential in neurospeech rehabilitation [6]. Drilling has reportedly led to network reestablishment as well as establishment of new connections, making needed changes feasible [19,20]. As such, amount of therapy is included under primary intervention principles [22].

Although often associated with monotonous, repetitive practices, conveying meaning and connotation to specific tasks and materials drilling demonstrates to be functional and pleasurable, leading to progress. Abundant naturalistic opportunities should support efficacy in implementation of treatment goals and objectives, conducting to more prompt results and generalization [6].

Additional aspects that should be considered in neurospeech rehabilitation planning involve specificity of training and instruction. Clear directions and consistent practice are also critical for best outcomes. Hence, learning and relearning should be supported by sufficient guiding and feedback, which also assist in content retaining and automaticity of learned components [23].

Exercise Quantification

A critical point in neurospeech treatment protocols involves exercising quantification, which is translated as frequency and duration of sessions as well as actual number of task repetitions, a key aspect in achieving optimal therapeutic results [24-26].

Despite unquestionability of neuro skills restoration by means of persistent repetition, clear indications of dosage may not be so substantial. Quantification of exercising in Speech-Language-Pathology (SLP) should be as clear as it happens for example with pharmacological prescription [27]. Further, treatment efficacy should be based on specific considerations for suitability, instead of a wide range of general methods, avoiding an 'one-size-fits-all' approach. It seems like quantification of dosage recommendations in nerospeech rehabilitation has been challenging [27].

High dosage recommendations

Recommendations of massive task repetitions for optimal rehabilitation outcomes are largely based in animal research, which may not readily translate to effects in humans [28,29]. The overall notion that an increased number of repetitions is more effective in all cases has been apparently also based on past seminal investigations favoring high dosages [27]. More recent research has generally validated this point [30]. Indications of benefits from high-frequency practice of speech targets include quicker acquisition of the targets and carryover of outcomes [31].

Dosage can be discussed in terms of intensity, frequency, and duration [28]. Intensity, defined by Pomeroy and colleagues as number of repetitions per or time per session, is labeled as amount by Lang and colleagues. Increasingly evidence suggests that amount or intensity should be prioritized [27]. Amount or intensity of the exercise required in animal studies has been reported to 300-400 repetitions in order to acquire a motor skill [28]. Again, this number likely does not translate directly to humans, but does provide an illustration of intensity of repetition.

However, a warning regarding general maximization of repetition numbers is related to timing issues, such as risk of poor outcomes of intervention close to brain injury onset [22,32]. While not conclusive, there is the suggestion that the first few hours and days may be a sensitive period with higher dosage therapy being counterproductive [27]. Further, confounding variables should be considered when examining relevant outcomes (e.g., strengthening results as opposed to skill enhancement) [18,33].

Fatigue: Additional physiological aspects should also be considered, such as weariness due to fatigue. This frequently self-reported symptom is usually described as tiredness that tends to increase in parallel with muscle exertion [34]. Fatigue is a term related to the overtaxing of the structures involved in the movement, which can be perceived as irregularities in the frequency, intensity, and quality of speech [6,35]. These signs and symptoms can obviously impact speech efficiency.

The Quest of Dosage

Finding consensus on clinically-oriented parameters is not an uncommon challenge, as specific areas in communication disorders face similar quests. For example, recent systematic reviews on methods in management of voice disorders, including some associated with neurogenic etiology, revealed inconsistent information [36].

It is reasonable to anticipate variations in treatment planning and associated recommendations with basis on underlying causes, onset, and factors intrinsic to the patient [5]. In many instances, loose referrals to commonly used number of trials (e.g., 10-20 consecutive repetitions) are prescribed [37]. Nevertheless, it becomes increasingly clear that there is a need of evidence-based reliable support for proper recommendations of timing, frequency, and intensity of treatment [36,38].

Clinical and Social Significance

The wealthy of existing information, as well as contemporary expertise and evidence guiding intervention in neurogenic-based speech disorders, would justify well defined methods for dosage recommendations. Strong indications of benefits achieved through diverse dose levels are urgently needed [22].

Further research is essential to develop evidence for generation of treatment protocols, warranting rigorous clinical methodology. SLPs should provide services that are appropriate, solidly founded on clinical rationale and research evidence.

Disturbances in the ability to produce intelligible speech communication may incur in life opportunity barriers that can lead to losses and disadvantages at personal and vocational levels [39]. In fact, functional disabilities imply limitations to perform within the environment [3]. According to the WHO's (2001) classification of disorders with basis on functional and social limitations, disabilities should be contemplated from different levels and perspectives: (a) structural level, (b) loss of function, (c) functional restrictions, (d) social limitations for the individual and (e) collective costs. As such, communicative limitations due to speech dysfunction may impose personal, interpersonal, and occupational restrictions that ultimately may result in social losses and can be disastrous. Consequences might include vocational and economic difficulties, in addition to other effects such as negative self-image, feelings of frustration, and social hindrances [40].

Understandable speech is acritical element in individual expression and in connecting with others. It is a means of expressing needs and feelings, sharing intellectual points, and controlling the environment. Hence, the ability of oral expression must be understood within a psychosocial context. In a society increasingly focused on functional participation and independent living, treatment approaches should be based on scientific evidence that includes reliable objective data as well as realistic input from individuals who apply the strategies in their own routine [7,41].

Conclusions and Recommendations for the Future

Possible approaches for obtaining further evidence include using data generated in natural clinical settings, in addition to trials reaching larger samples in controlled studies. A combination of clinical outcomes with empirical evidence from experimental investigations may be most feasible through a collaborative effort between clinical facilities and research institutions. Such combined resources can facilitate the establishment of systematic procedures and the development of treatment approaches to advance knowledge and application of effective clinical procedures.

In order to meet the communication needs of a growing population with neurologically-based speech disorders [6], clinicians are challenged to provide efficient services. This may not be a simple task, as consistent recommendations of key treatment parameters such as those related to exercising dosage, are not clearly indicated in the literature.

This paper is an attempt to highlight the importance of establishing reliable, consistent parameters and measures associated with speech exercising criteria in neurogenic-based speech disorders. It is therefore the intent of the authors to stimulate a constructive discussion on longstanding clinical procedures, perhaps originally based on concepts that may seem arbitrary under more current research practices and perspectives.

Therefore, the primary goal of this report was to generate an overall scenario of current dosage considerations for speech rehabilitation exercising. It is our hope that this introductory discussion may be considered when developing controlled studies in SLP practices. Finally, this paper could inspire advances in education about neurospeech rehabilitation.

The importance of providing effective services, based on clear information, has been increasingly recognized.Despite encouragement and expectations for including more specific recommendations in treatment protocols, there is great variability in implementation of neurospeech exercising dosage.Accurate identification of optimal dosing application for proper therapeutic procedures poses challenges even to experienced clinicians, and consequent frustration of clients and Significant Others (SOs). Although seeking controlled research is fundamental for establishing efficient methods to manage neurogenic-based speech disorders, this discussion underlines the need of team work in the application of systematic procedures leading to optimal clinical choices.

A variety of dosage approaches and strategies have been applied by SLP clinicians. The search for therapeutic efficacy should move past conventionally implied indications in neurospeech exercise recommendations and emphasize evidence-based supported methods.

References

1. Kent RD. (1997). The speech sciences. San Diego: Singular.
2. Roy N. (2011). Voice disorders in teachers. Perspectives on Voice and Voice Disorders. 21: 71-79.
3. World Health Organization (WHO). (2001). International classification of function in disability and health (ICF). Geneva, Switzerland: WHO.
4. United Nations Educational, Scientific and Cultural Organization (UNESCO). (2002). Universal declaration on cultural diversity.
5. Freed D. B. (2012). Motor Speech Disorders (2nd ed). Clifton Park, NY: Cengage.
6. Duffy J. R. (2012). Motor speech disorders: Substrates, differential diagnosis and management (3rd edn). St Louis, MO: Mosby.
7. Sackett D, Rosenberg W, Gray J, Haynes R, Richardson W. (1996). Evidencebased practice: What it is and what it isn't. British Medical Journal. 312: 71-72.
8. Yorkston KM, Beukelman DR, Strand EA, Hakel, M. (2010). Management of motor speech disorders in children and adults (3rd edn).
9. Hallet M. (2001). Brain plasticity and recovery from hemiplegia. Journal of Medical Speech-Language Pathology, 9: 107.
10. Lotze M, Braun C, Birbaumer N, Anders S, Cohen LG. (2003). Motor learning elicited by voluntary drive. Brain, 126: 866-872.
11. Druback DA, Makley, Dood ML. (2012). Manipulation of central nervous system plasticity: A new dimension in the care of neurologically impaired patients. Mayo Clinic Proceedings.79: 706-800.
12. Overman JJ, Carmichael ST. (2014). Plasticity in the injured brain: More than molecules matter. Neuroscientist. 20:15–28.
13. Kleim JA, Jones TA. (2008). Principles of experience-dependent neural plasticity: Implications for rehabilitation after brain damage. Journal of Speech, Language and Hearing Research. 51: S225-S239
14. Nudo RJ. (2013). Recovery after brain injury: Mechanisms and principles. Frontiers of Human Neuroscience. 7: 887.
15. Buonomano DV, Merzenich MM. (1998). Cortical plasticity: From synapses to Maps. Annual Review of Neuroscience: 21: 149- 186.
16. Salgado S, Williams N, Kotian R, Salgado M. (2013). An evidence-based exercise regimen for patients with mild to moderate Parkinson's disease. Brain Sciences. 3: 87-100.
17. Fridman EA, Hanakawa T, Chung M, Hummel F, Cohen LG, et al. (2004). Reorganization of the human ipsilesional premotor cortex after stroke. 127: 747–758.
18. Langmore SE, Pisegna. (2015). Efficacy of exercises to rehabilitate dysphagia: Acritique of the literature. International Journal of Speech Language Pathology. 17: 222-229.
19. Ludlow CL, Hoit J, Kent R, Ramig RL, Shrivastav R, et al. (2008). Translating principles of neural plasticity into research on speech motor control recovery and rehabilitation. Journal of Speech, Language and Hearing Research. 51: S240–S258.
20. Shum D, Fleming J, Gill H, Gullo MJ, Strong, J. (2011). A randomized controlled trial of prospective memory rehabilitation in adults with traumatic brain injury. Journal of Rehabilitation Medicine. 43: 216-223.
21. Adkins DL, Boychuk J, Remple MS, Kleim JA. (2006). Motor training induces experience-specific patterns of plasticity across motor cortex and spinal cord. Journal of Applied Physiology. 101: 1776–1782.
22. Cooke EV, Mares K, Clark A, Tallis RC, Pomeroy VM. (2010). The effects of increased dose of

exercise-based therapies to enhance motor recovery after stroke: A systematic review and meta-analysis. Biomed Central Medicine. 8: 60.

23. Clark HM. (2003). Neuromuscular treatments for speech and swallowing: A tutorial. American Journal of Speech-Language Pathology. 12: 400-415.

24. Birkenmeier RL, Prager EM, Lang CE. (2010). Translating animal doses of task Specific training to people with chronic stroke in 1-hour therapy sessions: A proof-of-concept study. Neurorehabilitation and Neural Repair. 4: 620-635.

25. Host HH, Lang CE, Hildebrand MW, Zou D, Binder EF, et al. (2014). Patient active time during therapy sessions inpostacute rehabilitation: Development and validation of a new measure. Physical & Occupational Therapy in Geriatrics. 32: 169-178.

26. Waddell KJ, Rebecca L. Birkenmeier, Moore JL, Hornby TG, Lang CE, et al. (2014). Feasibility of high repetition, task-specific training for individuals with upper extremity paresis. American Journal of Occupational Therapy. 68: 444-453.

27. Lang, CE, Lohse KR, Birkenmeier RL. (2015). Dose and timing in neurorehabilitation: Prescribing motor therapy after stroke. Current Opinion in Neurology. 28: 549–555.

28. Pomeroy V, Aglioti SM, Mark VW, McFarland D, Stinear C, et al. (2011). Neurological principles and rehabilitation of action disorders: Rehabilitation interventions. Neurorehabilitation and Neural Repair. 25: 33S-43S.

29. Wahl AS, Schwab ME. (2014). Finding an optimal rehabilitation paradigm after stroke: Enhancing fiber growth and training of the brain at the right moment. Frontiers of Human Neuroscience. 8: 381.

30. Kwakkel G, Veerbeek JM, van Wegen EE, Wolf SL. (2015). Constraint-induced movement therapy after stroke. Lancet Neurology. 14: 224-234.

31. Edeal DM, Gildersleeve-Neumann CE. (2010). The importance of production frequency in therapy for childhood apraxia of speech. American Journal of Speech-Language Pathology. 20: 95-110.

32. AVERT Trial Collaboration group. (2015). Efficacy and safety of very early mobilisation within 24 h of stroke onset (AVERT): A randomised controlled trial. Lancet. 386: 46-55.

33. Bell JA, Wolke ML, Ortez RC, Jones TA, Kerr AL. (2014). Training intensity affects motor rehabilitation efficacy following unilateral ischemic insult of the sensorimotor cortex in c57bl/6 mice. Neurorehabilitation and Neural Repair. 29: 590-598.

34. Verdolini K, Ramig LO. (2001). Review: Occupational risks for voice problems. Logopedics Phoniatrics Vocology. 26: 37-47.

35. Hillman RE, Mehta DD. (2011). Ambulatory monitoring of daily voice use. Perspectives on Voice and Voice Disorders. 21: 56-61.

36. Bos-Clark M, Carding P. (2011). Effectiveness of voice therapy in functional dysphonia: Where are we now? Current Opinion in Otolaryngology, Head & Neck Surgery. 19: 160-164.

37. Dworkin JP. (2012). Motor speech disorders: A treatment guide. St. Louis, MO: Mosby.

38. Walton C, Conway E, Blackshaw H, Carding P. (2017). Unilateral vocal foldparalysis: A systematic review of speech-language pathology management. Journal of Voice. 31: 509.e7-509.e22.

39. Schindler A, Ottaviani F, Mozzanica F, Bachmann C, Favero E, et al. (2010). Cross-cultural adaptation and validation of the voice handicap index into Italian. Journal of Voice. 24: 708-714.

40. Niebudek-Bogusz E, Fiszer M, Kotylo P, Sliwinska-Kowalska M. (2006). Diagnostic value of voice acoustic analysis in assessment of occupational voice pathologies in teachers. Logopedics Phoniatrics Vocology. 31: 100-106.

41. Ratner NB. (2006). Evidence-based practice: An examination of its ramifications for the practice of speech-language pathology. Language, Speech and Hearing Service in Schools. 37: 257-267.