The Effect of Augmented Feedback and Expertise on Spinal Manipulation Skills: An Experimental Study

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Abstract

Objectives: The purpose of this study was to investigate the combined effect of augmented feedback and expertise on the performance and retention of basic motor learning spinal manipulation skills.
Methods: A total of 103 chiropractic students with various training expertise were recruited for the study. Participants were evaluated at baseline, immediately after trials of augmented feedback practice and 1 week later. During all 3 assessments, students were asked to perform several trials of the same spinal manipulation, for which the maximum preload force, onset of thrust, thrust duration, force and peak force, thrust duration, rate of force application, and any drop in preload force were calculated. The constant error, absolute error, and variable error were calculated for the 3 experimental blocks of trials.
Results: Results confirmed that augmented feedback training modified several biomechanical parameters such as the rate of force application, the preload force, and the drop in preload force. The study also confirmed that many biomechanical parameters, including thrust duration and rate of force application, are modified with expertise but failed to identify any interaction effect between expertise and augmented feedback training effects.
Conclusion: The study determined that expertise did not influence how students performed after a session of augmented feedback training. The study also determined that augmented feedback related to the global performance can yield improvements in several basic components of the spinal manipulation task. These results should be interpreted considering basic motor learning principles and specific learning environments. (J Manipulative Physiol Ther 2017;40:404-410)
Key Indexing Terms: *Spinal Manipulation; Feedback; Learning; Education; Expertise*

Introduction

Spinal manipulation (SM) is a tool commonly used in manual therapy, and it is the typical treatment administrated by chiropractors.[1] In each chiropractic teaching institution, an important part of the curriculum is dedicated to this learning. Spinal manipulation is characterized by a dynamic thrust of high velocity and low amplitude using a specific contact and direction associated with an audible cavitation. It can be described as an action requiring high-speed, low-amplitude precision that has mechanical consequences.[2] From an experimental standpoint, spinal manipulation is usually described using the basic biomechanical features characterizing its force-time profile, such as peak force, preload force, thrust duration force, and rate of force application.[3]

Although the SM force–time profile is rather stable across experienced clinicians, spinal manipulation can prove to be a complex motor skill depending on the technique used and the segment being treated. As in any motor task, the learning of spinal manipulation requires pedagogic strategies and training regimen based on repetition and feedback.[4] In many cases, spinal manipulation involves postural control and timely synchronization of lower limb and trunk body weight transfer during upper limb force transmission. Mastering these complex skills and proper coordination of the multiple body segments involved enable a better regulation of forces that are applied during a treatment.[5] Previous studies comparing levels of expertise and motor performance during learning suggest that these more complex components of SM are not easily mastered during training years.[6] Although scientific evidence is limited, the planning and organization of SM skill learning can affect students' motor performance and overall SM skill expertise.[7]

Indeed, several studies have explored the relevance of feedback training in spinal manipulation education. These studies have explored the effect of feedback in various

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Paper submitted January 11, 2017; in revised form February 17, 2017; accepted March 14, 2017.
0161-4754

http://dx.doi.org/10.1016/j.jmpt.2017.03.010

populations ranging from inexperienced students without any clinical training to students and clinicians with significant clinical experience.[8] Various devices, all based on force-sensing technologies, were used to provide feedback to students and to assess performances.[9,10] In a few studies,[11,12] feedback training was provided using force-sensing devices (no patients), whereas performance assessments were conducted on patients (other students). Altogether, these studies suggest that augmented feedback, defined as "information provided about the action that is supplemental to, or that augments, the inherent feedback,"[13] using force-sensing devices during training improves SM skill performance and reduces variability. Interestingly, only 2 studies included short-term learning retention assessments (1 week after training)[9,10] after augmented feedback training. One could therefore argue that these studies mostly describe improvements in performance rather than true motor learning, usually defined as permanent changes in a person's capability to execute a motor skill.[14] As highlighted in a recent best-evidence synthesis by Stainsby et al.[15] several mechanical or computerized training aids providing extrinsic forms of feedback have been developed and studied over the past 2 decades. The various training aids are usually developed to address the motor learning challenges faced by students and teachers, and the authors of this best-evidence synthesis concluded that such devices are useful to promote skill development, knowledge transfer, and task retention among students. Overall, although there is no doubt that feedback can improve short-term SM performance and consistency, its effect on motor learning assessed trough retention and transfer tasks is less documented. The effect of various types of augmented feedback as well as optimal strategies, including frequency, timing, and accuracy of augmented feedback in SM skill learning remain to be investigated.

In this study, 3 groups of chiropractic students with varying expertise were compared on 3 different occasions: (i) baseline evaluation, (ii) after augmented feedback training, and (iii) 1 week after augmented feedback training. The goals of the study were 2-fold. The first goal of the study was to reaffirm, in a large sample of students, that biomechanical parameters of SM are influenced by the level of expertise and are improved after augmented feedback training. The second goal was to assess how expertise modulates the effect of augmented feedback use during SM training. Several models describe the stages of motor learning[16,17] as a process through which most learners evolve from a verbal-cognitive stage to an independent-automated stage characterizing expertise. Based on such models, it was hypothesized that augmented feedback related to the global performance and reinforced by specific feedback on peak force, thrust duration, and preload force using SM the force–time profile would mostly favor early SM learners.

Methods

Design

This was an experimental study.

Participants

Participants were all recruited among the first-, third-, and fifth-year chiropractic students (group 1, 2 and 3, respectively) using convenience sampling. Based on previous SMT motor learning studies indicating significant expertise effects, it was estimated that a minimum of 20 participants per group was needed to reveal expertise and training effects.[18] The study was approved by the Institut Franco-Européen de Chiropraxie Ethics Committee (2016_02_26) and each participant provided a written informed consent. Participants' characteristics for each group are presented in Table 1.

Experimental Sessions

The study was divided in 3 different assessments over 2 experimental sessions that were preceded by a 15-minute presentation of the project. During this presentation the protocol and the SM task were briefly explained and demonstrated using a video presentation and both novice and expert SM force-time profiles. Typical characteristics of novice force–time profiles, such as lack or drop in preload force and longer thrust duration, were pointed out to participants. During the first experimental session, each participant performed a total of 53 SMs on an instrumented device using a unilateral hypothenar transverse push technique with a posterior-to-anterior force vector. Participants chose their preferred contact hand and table height to perform the SM and were instructed to perform SM using the same hand during the all assessments. The SMs were performed by contacting the target on the device in a fencer position with the caudal hand pisiform. A familiarization period was first offered and consisted of 3 trials per participant, during which they were instructed to perform SMs of 300 N peak force while trying to replicate expertlike force–time profile. Baseline assessment was conducted during the following 10 trials, which were also performed with a target peak force of 300 N but without feedback. During the training period, participants performed 30 SMs and were provided with both verbal and visual feedback. A global performance feedback was provided verbally and reinforced, when necessary, by specific quantified feedback on peak force, thrust duration, and preload force drawn from the previous SM force–time profile. Post-training assessment consisted of a set of 10 trials without any feedback and with a 300-N peak force target. After a 7-day retention period, a third assessment was conducted during which participants also performed 10 trials without feedback using a 300-N peak force target after familiarization trials. All 3 sets of 10 trials collected at baseline, during the post-training, and at the retention assessment periods were used in the data analysis.