Gait & Posture 38 (2013) 68–72

Contents lists available at SciVerse ScienceDirect

Gait & Posture

journal homepage: www.elsevier.com/locate/gaitpost

Effects of visual interference on initial motor program errors and execution times in the choice step reaction

Kazuki Uemura [a,b], Toshihisa Oya [a], Yasushi Uchiyama [a,*]

[a] Department of Physical Therapy, Graduate School of Medicine, Nagoya University, Japan
[b] Japan Society for the Promotion of Science, Japan

ARTICLE INFO

Article history:
Received 11 January 2012
Received in revised form 9 October 2012
Accepted 25 October 2012

Keywords:
Attention
Postural control
Executive function
Judgment

ABSTRACT

The purpose of this study was to examine whether visual interference has any effect on error in the initial direction of anticipatory postural adjustment (APA) prior to a step (indicating a motor program error) and response time during the choice step execution. Twenty healthy young participants were instructed to execute forward stepping as quickly and accurately as possible on the side indicated by a central arrow (←, left vs. →, right) of a visual cue in the neutral condition. In the flanker condition, they were additionally required to ignore the 2 flanking arrows on each side (→→→→→, congruent or →→←→→, incongruent). Errors in the direction of the initial weight transfer (APA errors) and the step execution times were measured from the vertical force data. In the incongruent condition, the percentage of APA errors and the step execution times were significantly greater than those in the neutral and congruent conditions. A linear mixed model revealed that the step execution time in trials with APA errors was longer than those in trials without APA errors. The visual interference effect of a flanker task may load selective attention and judgment processing during movement initiation, leading to increased initial motor program errors and prolonged step execution times even in healthy young adults.
© 2012 Elsevier B.V. All rights reserved.

1. Introduction

The ability to respond rapidly to environmental stimuli is a vital human sensorimotor function [1]. During everyday locomotion, it is often necessary to quickly initiate a step to avoid potentially threatening situations such as collisions, obstacles, and falls. Delayed initiation and completion of a voluntary step is a marker of an increased risk of falling in older adults [2–4]. To effectively minimize such occurrences, the processing and judgment (reaction), postural (weight transfer), and locomotion (step) components must be timed and executed appropriately [1,4]. Tests that have been previously used for assessing the physical performance, including walking speed and step reaction time, could not evaluate the multiple aspects of postural control deficits and the potential mechanism of movement prolongation.

Anticipatory postural adjustment (APA) was originally defined as a change in postural control associated with voluntary movements; it occurs before the onset of the disturbances of posture and equilibrium resulting from a movement [5]. To prepare for a step, the body weight is normally shifted laterally onto the stepping foot in preparation for shifting weight onto the support leg; this is considered to be the APA during step initiation [6,7]. APA begins at the time of initiation and ends at the time of completion of the preparatory weight transfer (i.e., foot-off) [6–10]. Cohen et al. [11] reported that errors in the direction of initial weight transfer, which is defined as an APA error, account for slow choice step execution because the APA error must be corrected before the step can be safely executed. Given that an initial motor program error leads to incorrect and prolonged APA, processing and judgment may be vital and critical in determining the accuracy and speed of step execution. It is possible that loading the processing and judgment will lead to clarification of potential deficits in postural control during step initiation.

Flanker interference tasks are used as selective attention tasks to measure conflict resolution and visual interference effects [12–14]. In such flanker tasks, subjects are usually required to identify the direction of a central arrow flanked by incongruent or congruent stimulus arrays by manually pressing a button. Flanker task performance (i.e., reaction time) deteriorates with increasing age [14], particularly in patients with mild cognitive impairment and Alzheimer's disease [15,16]. Voluntary upper extremity responses might bear little resemblance to postural reactions for avoiding potentially threatening situations in daily life, such as a stepping reaction. In addition, performance of upper extremity responses, which is hardly divided to several components by

* Corresponding author at: Graduate School of Medicine, Nagoya University, 1-1-20 Daikouminami, Higashi-ku, Nagoya 461-8673, Japan. Tel.: +81 52 719 3155; fax: +81 52 719 3155.
E-mail addresses: uchiyama@met.nagoya-u.ac.jp, kazuki.uemura@gmail.com (Y. Uchiyama).

0966-6362/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.gaitpost.2012.10.016

individual function, can be evaluated by a single parameter (i.e., reaction time) if they include an incorrect initial impulse. Assessing stepping performance in response to the flanker task may enable us to investigate the processing and judgment during movement initiation, which simulates real-life situations requiring immediate judgment and action. Analysis of the individual phase would reveal the contributing factor for movement prolongation with respect to several components such as processing, initial APA, and stepping itself. It was previously reported that stepping accuracy in response to the selective attention task is associated with a risk of falling in older adults [17]. However, the details of stepping performance, such as initial motor program error and stepping speed, have not been evaluated.

The present study focuses on selective attention and judgment processing during movement initiation; these are critical components that determine the accuracy and speed of step execution. We hypothesized that if visual interference can load the judgment process and increase the potential deficits in choice step execution, then the flanker task may increase initial motor program errors (i.e., APA errors), which contribute to the prolongation of step execution because of the additional time needed to correct the erroneous APA. Therefore, the purpose of this study was to determine whether visual interference has any effect on the initial motor program and choice step execution and whether the presence of an APA error influences the response times and step execution in healthy young adults.

2. Methods

2.1. Participants

Twenty healthy young subjects participated in this study; these included 8 women and 12 men, with a mean ± SD age of 22.5 ± 0.9 years; height, 166.0 ± 10.7 cm; and body mass, 58.9 ± 8.4 kg. In accordance with the Declaration of Helsinki, the participants were informed of the experimental procedure, and each submitted a written informed consent before participation in the study. The experimental procedure was approved by the local ethics committee (Graduate School of Medicine, Nagoya University, approval no. 11-514).

2.2. Task and design

During each trial, the participants viewed a display that contained visual cues; they initially stood upright on 2 separate force platforms, with their heels separated mediolaterally by 6 cm so that every trial would begin from the same position. The visual display was set 1 m in front of the participants at eye level. Before each trial, the participants were required to stand with their weight evenly balanced. If 1-sided weight distribution was detected between each force plate, the participant was instructed to shift the weight to the left or right to achieve an approximately balanced weight distribution (not more than 55% of weight on either foot) before starting the trial. They were instructed to execute forward stepping as quickly and accurately as possible on the side indicated by the central arrow (←, left vs. →, right), moving their foot 30 cm on each step trial. In 1 block (neutral condition), only 1 arrow was shown in the same central location on the display. In the other block (flanker condition), the visual display contained 5 arrows; the participants were asked to indicate the direction the central arrow was pointing while ignoring the 2 flanking arrows on each side. In half the trials, the flanking arrows pointed in the same direction as the central arrow cue (←←←←← or →→→→→; congruent condition), while in the other half, the flanking arrows pointed in the opposite direction (←←→←← or →→←→→; incongruent condition). In the incongruent condition, the flankers provided conflicting information that caused interference, typically resulting in an increase in response errors. The direction of the central arrow and each flanker condition (congruent or incongruent) appeared randomly. The neutral condition contained 8 trials, whereas the flanker condition contained 16 trials, including equal numbers of congruent and incongruent conditions. The 2 conditions were blocked and counterbalanced, with every participant completing 24 trials in total.

2.3. Instrumentation and data analysis

The vertical force data during the step execution were collected using 2 separate force platforms (Twin-gravicorder G-6100, Anima Co., Tokyo, Japan). The force platform data were sampled at 500 Hz. Specific temporal events were extracted from the step execution data using a program written in MATLAB (MathWorks Inc., Cambridge, MA, USA). Fig. 1 shows data for the vertical force under both feet as a percentage of body weight, obtained during the 2 trials of step execution by the right foot. Fig. 1A shows a trial in which the initial APA was in the correct direction (i.e., increased force under the swing foot to be lifted). Fig. 1B shows a trial in which the initial APA was in the wrong direction (i.e., increased force under the initial stance leg), which delayed the step. The following events were extracted from the vertical force data: (1) APA onset, the first time the difference in vertical force under the 2 feet increased by 5% of the body weight; (2) APA errors, trials in which the participants executed an APA in the incorrect direction

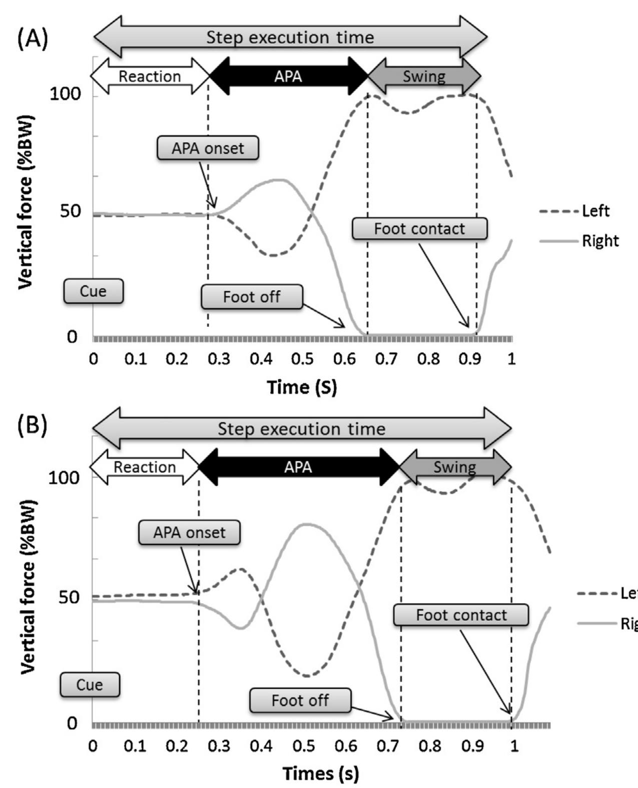

Fig. 1. Two example data of the step execution trials with the right foot, with vertical force expressed as a percentage of body weight. (A) A trial with a correct initial APA. (B) A trial with an initial APA error. The following events were extracted from the vertical force data: (1) APA onset, the first time the difference in vertical force under both feet increased by 5% of the body weight; (2) APA errors, trials in which the participants executed an APA in the incorrect direction, subsequently corrected that APA, and stepped with the correct foot; (3) foot-off, the first moment the vertical force under either foot decreased to zero; (4) foot contact, the first moment the vertical force under the swing leg exceeded 10 N. BW, body weight.

Download English Version:

https://daneshyari.com/en/article/6207497

Download Persian Version:

https://daneshyari.com/article/6207497

Daneshyari.com