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Short communication

Self-Selected walking speed increases when individuals are aware of being recorded

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ABSTRACT

Background: Typical gait data collections consist of discrete walking trials where participants are aware when data are being recorded. Anecdotally, some investigators have reported that participants often walk differently between trials or before or after data collection compared to when they know they are being recorded. In addition, walking speed, which affects a number of gait variables, is known to be different when individuals complete discrete and continuous walking trials.
Research question: The purpose of this study was to determine whether changes in walking speed occurred as a result of participants being aware, versus unaware that data were being recorded, during both discrete and continuous walking trials.
Methods: Kinematic data were collected for twenty two individuals walking continuous trials or discrete trials, while they were both aware and unaware of being recorded. Comparisons of walking speeds were made between groups (continuous walking; discrete trials) and awareness of being recorded (aware; unaware) using a two way ANOVA.
Results: The results indicated that participants walked significantly faster during discrete trials when they were aware that data were being recorded compared to when they were unaware. However, when they walked continuously their walking speed was not affected by their awareness.
Significance: The results suggest that awareness of data collection, and the type of protocol used during data collection, affect an individual's walking speed during gait analysis. Therefore, care should be taken when determining gait analysis protocols where variables are sensitive to walking speeds.

1. Introduction

Walking speed is established as a global descriptor of walking quality [1]. Other gait measures, such as joint moments and power, ground reaction forces, and minimum toe clearance, have all been shown to be affected by walking speed [2–5]. Additionally, gait speed is an important metric during geriatric gait assessments [6–8] and determining risk thresholds [9]. During gait data collection sessions it is common practice to collect dynamic data during discrete trials with designated spatial and temporal starts and endings, which is not how individuals typically walk during normal daily life. Previous reports demonstrated higher inter-trial variability of speed-dependent outcome measures in younger and older females during discrete walking trials compared to during continuous walking [10] and that discrete trials result in faster walking speeds than trials that are collected while participants walk continually, for both males and females [11]. Therefore, variables that are affected by walking speed, and the variability of such variables, may be different during discrete walking trials compared to a participant's 'normal', continuous walking. These differences in outcome measures could potentially affect the reported outcomes of any gait analysis involving statistical tests and data interpretation [11].

During data collection sessions participants are often aware of when their movements are being recorded. Walking trial methods and descriptions vary widely between laboratories and studies, with no recognized "gold-standard" format for participant instructions or start and endpoints [12]. Anecdotally, some operators report differences in individuals' gait when they think that data collection is over or paused, or before the collection has started, compared to when data are being recorded. However there is little empirical evidence supporting, or

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refuting, these operator-perceived differences due to participants' awareness of data being recorded. Therefore, the purpose of the present study was to determine whether walking speed changed when the participants were aware that data were being recorded, compared to when they were unaware during both continuous and discrete walking trial types.

2. Methods

Twenty-two healthy individuals (5 females, mean (SD) age: 22 (2) years, height: 179 (7) cm, mass: 73 (14) kg), who gave written informed consent prior to data being collected, participated in the study, which was approved by the institutional ethics committee. Opto-reflective markers were placed bilaterally above the heads of the first and fifth metatarsals, calcaneus, lateral and medial malleoli, lateral and medial femoral epicondyles, the anterior and posterior superior iliac crests, and the tibial tuberosities. Participants also wore four-marker clusters, on their thighs and shanks. All participants wore their own, flat soled shoes throughout.

All participants were given detailed, explicit instructions that data would be collected as they walked from a start line to a finish line, 12 m apart. This was done in such a way to imply that data would not be collected at any other time. Half the participants were told that once they had crossed the finish line they should stop, turn around, and return to the start line and to stop there and wait for instruction before commencing the next trial, when data would again be recorded from the start to the finish line. The other half of the participants were likewise told to turn around and return to the start line once they reached the finish line. They were further instructed not to stop when they got back to the start line, but to continue walking and that data would be collected each time they walked from the start to the finish line. This resulted in 11 participants walking in discrete trials and 11 participants walking continuously. A between groups design was chosen to reduce the possibility of participants "guessing" the purpose of our study. Skin-mounted marker trajectories were recorded using an 11-camera system (Qualisys, Gothenburg Sweden) at 200 Hz for all participants while walking from the start line to the finish line and while walking from the finish line to the start line. For the analysis, the data recorded while walking from the start to the finish line were regarded as the trials where the participants were aware that data were being recorded. The data recorded when the participants were walking from the finish line to the start line were considered as being the trials during which participants were unaware.

All marker data were processed in Visual3D (C-Motion, Germantown MD, USA). They were filtered with a fourth-order, low-pass butterworth filter with a cut-off frequency of 6 Hz A pelvis segment was created using the four pelvis markers. Walking speed was defined as the mean forward velocity of the centre of mass of the pelvis segment through the data collection volume [11,13], which was the central four meter length of the walkway. Walking speed variability was defined as the inter-trial standard deviation of walking speed [10,11]. Comparisons of walking speed and walking variability were made using a two-way analysis of variance (ANOVA) with trial type (discrete trials, continuous walking) and awareness (aware, unaware of data being recorded) as factors. Pairwise comparisons were performed using a Tukey test. The alpha level was set at 0.05.

3. Results

The ANOVA revealed p-values for each main effect on walking speed ($p = 0.040^*$ for awareness, and $p = 0.490$ for trial type). However, more importantly, the analysis revealed a significant interaction between the effects of awareness and trial type ($p = 0.035$). Pairwise comparisons revealed that individuals walked faster when they were aware of being recorded during discrete trials compared to when they were unaware ($p = 0.005$); however when they walked continuously their walking speed was not affected by awareness of being recorded ($p = 0.963$, Fig. 1). There were no significant effects of trial type ($p = 0.094$) or awareness ($p = 0.080$) on variability of walking speed, and no interaction effect between variables ($p = 0.217$, Fig. 2). Pairwise tests showed significant differences in walking speed variability between discrete and continuous trials when participants were aware their data was being recorded ($p = 0.037$) and between aware and unaware conditions during continuous trials ($p = 0.039$).

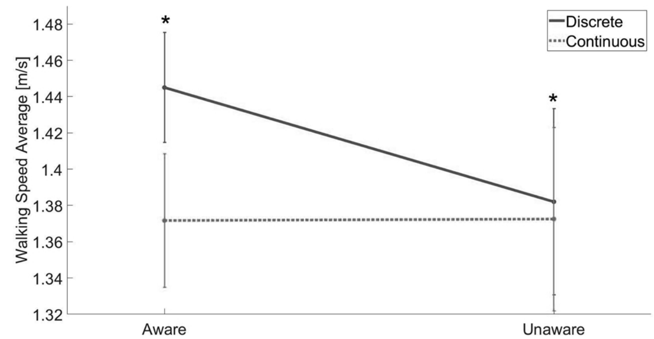

Fig. 1. Group average (SEM) walking speed during discrete (dark, solid) and continuous (light, dashed) walking trials while aware (left) and unaware (right) of data collection. Significant difference (P = 0.048) was found between aware and unaware, discrete walking trials (*).

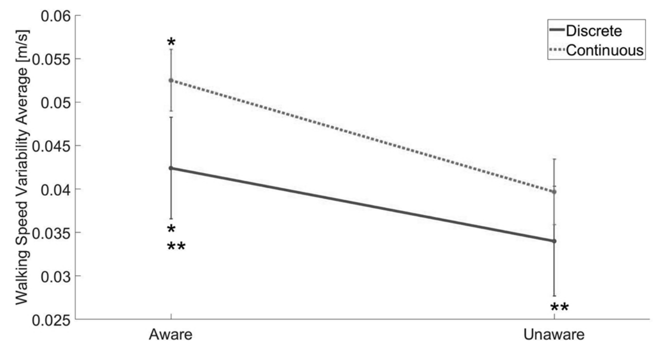

Fig. 2. Group average walking speed variability (SEM) during discrete (dark, solid) and continuous (light, dashed) walking trials while aware (left) and unaware (right) of data collection. Significant differences (P = 0.0371) were found between discrete and continuous aware trials (*), and between continuous trials (P = 0.0388) when subjects were aware and unaware (**).

4. Discussion

During traditional gait lab collections, operators report anecdotal evidence of participants walking differently prior to collections or after a trial has finished. The present study investigated the effect of awareness on walking speed and walking speed variability. Individuals walked, on average, 0.06 m/s (4%) faster when they were aware than when they were unaware they were being recorded during discrete trials. Although not statistically significant, there was a tendency for increased walking speed variability during discrete trials when they were aware of data being recorded than when unaware. The difference in walking speed may not appear large, however De Asha et al. reported significant speed-related changes in joint kinetics in trans-tibial amputees' gait with an average change of 0.06 m/s between experimental conditions [14] during discrete trials. Also, while again not a statistically significant finding, walking speed was, on average, 18% more variable during discrete trials where participants were aware data were being recorded compared to continuous trials where they were not aware (Fig. 2). These trends, together with the pairwise comparisons, corroborate a previous study's finding of increased walking speed variability during discrete walking trials compared to continuous walking [6].

Lythgo et al. found that participants walked faster shod than when walking barefoot [15]. Future studies should therefore investigate the effects of awareness on shod versus barefoot walking to determine if they are still valid. Our results indicated that there was no significant difference in walking speeds between discrete and continuous walking trials. This differs from our previous study where we reported that participants walked significantly faster during discrete trials than continuous walking trials [11]. The different findings between the two studies is likely attributable to differences between study designs. In the previous study, participants walked continuously in a figure-of-eight pattern, where the change in direction was gradual rather than abrupt. This suggests that straight-line walking speed may be affected by the nature of any direction change beforehand, which appears logical. Additionally, the previous study was designed so that participants walked both discrete and continuous trials to determine differences within a single participant group, while the present study was designed to detect differences in awareness between separate participant groups.

The results of this study further demonstrate the effects of gait laboratory environments on individuals' walking speeds, and consequently on speed-related outcome measures. Together with previous studies [10,11], this study suggest that continuous walking is more representative of "normal" walking than discrete trials.

Conflict of interest

The authors declare that there is no conflict of interest.

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