Examining the Impact of Dual-Tasking on Gait of Health Individuals

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2 INTRODUCTION

2.1 BACKGROUND & LITERATURE REVIEW

With recent developments in science and technology, a variety of smartphones has become deeply integrated into the everyday lives of people. Due to the everyday use of this form of technology, a number of people perform various tasks simultaneously on their smartphones while on the move. The process of multitasking and walking showed that there was a difference in the gait pattern of such individuals in comparison to those persons that did not perform any type of multitasking on their phones. Variables such as gait velocity and degree of deviation were noted to be different among multitasking and non-multitasking individuals as observed by Jeon et al. (2016).

Lee and Choi (2012) conducted a systematic literature review to ascertain the various variables studied in the performance of gait among stroke patients. It was found that most of the studies concluded that stroke patients have difficulty in conducting two or more motor tasks at the same time which leads to one of the tasks being naturally preferred activity (Lee and Choi, 2012). Since the early 2000s, a majority of the studies on stroke patients asserted that implementing dual tasks as simple as the combination of walking, cognitive performance, or exercise tasks were enough to examine the gait performance of stroke patients (Lee and Choi, 2012).

Lamberg et al. (2012) observed that the activation of the memory system decreases in the situation of normally speaking over the phone while walking as compared to those individuals that are text messaging, which increases the overall distance covered. Hatfield et al. (2007) and Lamberg et al. (2012) also discovered that gait velocity decreases, limited the number of words in a text message, and when people speak on the phone the awareness of the surrounding environment decreases automatically.

Studies such as Haspashyl et al (2018) analysed the impact of dual tasks on gait, balance, and velocity of participants of the stroke population to better comprehend physical rehabilitation processes. The study used a quasi-experimental design among 100 randomly selected patients to test the gait and cognitive performance of stroke patients. The factors analysed in Haspashyl et al. (2018) were used in the current study to measure healthy individuals. Furthermore, Liu et al. (2017)

reviewed the cognitive and motor skills to improve the gait performance of stroke patients. The study focused on cognitive tasks of serial subtraction and the physical task of carrying a tray. The results of the study indicated that cognitive dual-task training and motor dual-task training improved gait performance and different types of dual tasks gait training can be adopted to enhance different dual-task gait performances in stroke patients. By examining the results and experimental setup of Liu et al. (2017) the current study adopts cognitive performance through texting using a smartphone.

A systematic review by Wang et al.2015 examined the effectiveness of dual-task training in stroke and concluded that dual-task training can effectively improve gait function in stroke patients in the short term. However, there are methodological concerns that pose threats to the validity of their conclusion. Further studies also reported that in stroke individuals, reductions in speed, cadence, and stride length during cognitive-motor dual-tasking have been reported (Hyndman et al, 2006; Al-Yahya, 2011). This indicates that stroke subjects had more difficulty executing motor dual tasks compared to healthy adults (Yang, 2007).

The use of smartphones allows a person to perform a multitude of tasks at any time simultaneously and hence cause concentration to be both diverted from the surroundings and divided among the different tasks being carried out. The result of this division in concentration leads to walking deviations which may lead to unforeseen situations such as accidents (Wilmer et al., 2017). A study conducted by the Kyunganam University (Jeon et al., 2016) showed that the changes in the gait pattern are irrespective of age, gender or any other physical factor but is solely based on the concentration of the person on the task(s) that they are carrying out on their smartphone.

Lin and Huang (2017) argue that the issue of motor-cognitive interference based on the activity of multi-tasking on a smartphone is not well studied. The complete absorption of an individual that is using their smartphone to multitask and how it affects the roadside awareness is observed in completely healthy individuals with no record of any form of muscular issues or walking issues (Lin and Huang, 2017). It was observed that the type of tasks being carried out while walking also has a significant effect on the gait of individuals. It was noted that any application that requires the user to carry out extensive reading reduces their awareness of the roadside surroundings (Lin and Huang, 2017). The response time of the individuals was also noted in response to events and situations that occur in the surrounding environment. Lee and Lee (2018) worked on analysing the overall influence of smartphone multitasking on the gait and dynamic balance of an individual.

2.2 Research Aims & Objectives

The primary research question of the current study was developed as;

- Does multi-tasking, like texting, impact the gait of healthy individuals?

The primary aim of the current research is to examine the impact of multi-tasking on the gait of healthy individuals. To achieve the aim of the research the following objectives have been devised:

1. Examine the using laboratory equipment the impact of texting on the gait of healthy individuals.
2. Analyse the changes in velocity when conducting multi-tasking.
3. Analysing the change in cadence when conducting multi-tasking.

3 Methods

3.1 Participants

The research experiment was conducted using sixteen participants (N=16) with ages between 18 and 65 years. Participants were selected using convenience sampling as limited time and resources hindered a broader study. The current experimentation involved participants that were teachers' staff and post-graduate students from the University's Department of Physical Therapy. The research required a set of inclusion criteria that allowed for specific people to participate in the study. The inclusion criteria are:

1. Participants will not have a pre-existing musculoskeletal injury.
2. Participants will not be using any kind of medication that may affect gait design.
3. Participants' cognitive functions must be intact.
4. Participants will not have any pre-existing visual impairments.

5. Participants will need to use their own smartphones.

All participants in the study used for experimentation need to have met these criteria, all others were excluded from the study. Before the participants are included in experimentation, a detailed consent was provided that detailed the study aims, the procedure, and expressed that all participants will remain anonymous. Data that is used in the research will be stored securely and used with the utmost responsibility on the part of the researcher. Once participants are informed of the research, they are asked to sign consent forms that are held by the researcher.

3.2 Equipment

To conduct the experiment of gait and dual tasking in a laboratory setting, a GAITRite© was used. The GaitRite is a 5-metre-long mat with sampling capability at 80Hz. This mat was positioned in the laboratory along a 20-metre oval circuit. The circuit starts 1.5 metres before the GaitRite mat. GAITRite using in analysing gait spatial and temporal parameters such as velocity, cadence, and stride length. GAITRite allows researchers to measure the temporal gait variables and the spatial gait characteristics of functional gait index accurately through a computerized analysis. The GaitRite system has embedded validity and reliability that is established for both healthy individuals and the stroke population (Menz et al., 2004). When compared with a video-based motion analysis system, GaitRite has strong concurrent validity and test-retest reliability for measuring gait parameters such as gait speed, cadence and stride length (ICC range from 0.85–0.94) (McDonough et al.2001; Bilney et al.,2003). The setup of the equipment is illustrated in the figure below.

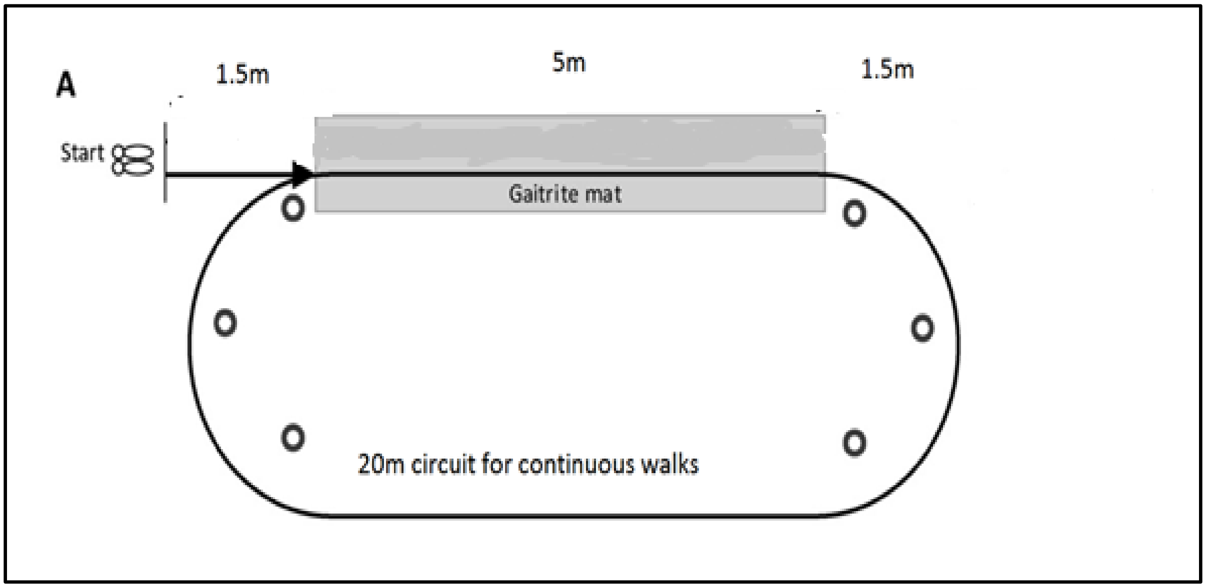

Figure 1- Gait and Dual Tasking Laboratory Setup

In addition to the experimental setup, participants that consented to take part in the study were asked to put on flat and comfortable shoes. Furthermore, the participants of the study were required to use their own mobile phones, specifically smartphones. It was required that the auto-correct features, predictive text features, and check spelling functions were turned off.

3.3 Procedures

To aid in ensuring that participants fully understood their part in the research and minimise the presence of motivational bias from the researchers, a standardised instructions sheet was provided to participants (Montibeller & Von Winterfeldt, 2015). Participants were required to perform the double tasks, which includes walking and texting; or a single task of walking only. The task assigned to a participant is on a random basis to protect against accidental bias and minimise the effects of selection bias (Suresh, 2011). The process of randomising participant tasks was conducted using lots.

Each task assigned to participants had one trial, this meant a two-minute rest break was ensured between the tasks to minimise the impact of fatigue and ensure that participants in the study were fully concentrated on their specific task. This two-minute rest break also allowed the setting up of GaitRite by the research, a stopwatch for the recording and saving the results of the 1st trial while preparing for the trial by any changes needed.

The following tasks that are included in the trial are:

1. Single task- walking ten circuit laps around the designated area.
    a. A subject who had dual-tasking randomization for the first task would be required to continuously text a prearranged message to the researcher after the researcher's number has already been included in the phone. The process is conducted for about 30 secs. The subjects are, however, not required to make any corrections of errors in their texts.
    b. The prearranged message for texting the researcher was "A blue bird." The text was used because it is familiar and easy to be written by the participants, especially international students. The text was to be sent via WhatsApp.

2. Dual-task- walking and texting simultaneously for ten circuit laps around the designated area.
    a. Participants were asked to continuously send the prearranged message from their mobile phones to the researcher's phone while walking on the ten-lap circuit until when the researcher told them to stop. The message was sent via the WhatsApp application.
    b. The same phone was used by the researcher to receive the text message.
    c. The prearranged message, in this case, was "I love pets". The text was different from the text sent while standing to prevent adaptation and the learning process that accompanies the typing of similar texts. The reason behind the selection of "I love pets" was because of the equality of characters and words with the first text, i.e., "A blue bird".

3.4 Data Collection

Researchers involved in the project were assigned specific tasks. One of the researchers were tasked with the responsibility of operating the computer GaitRite system. This meant ensuring that equipment and system were functioning as required. The second researcher of the study was tasked with estimating the complete time for each trial taken by the participants when texting, counting the laps around the circuit, and directing the participants to when the test is completed. The 2nd research used a stopwatch to estimate the time required to walk the ten circuit laps for dual and single tasks.

The researcher also collected data on the speed of typing by the number of characters per minute to make estimates during the dual-task of participants. A mark is present at 1.5 metres before the GaitRite mat starts and another marker that is 1.5 metres after the end of the mat (see figure 1). This was used to ensure that participants were recorded when their walking speed was at an estimated constant. The ten circuit laps were conducted on the circuit for each protocol of 20 meters for the test while walking and standard walking. The second researcher used a stopwatch to approximate the time required to walk the ten laps in the circuit lap for both single and dual tasks. The speed of typing in terms of characters per min was estimated during the dual-task. Data that was collected on gait factors was recorded using GaitRite and exported to an Excel spreadsheet. The dual-task cost was calculated using the formula:

$$DTC = \frac{\text{dual-task result} - \text{single task result}}{\text{single task result}} \times 100$$

4 Results

To conduct the data analysis on the data collected, IBM SPSS v. 24 was used to depict descriptive and inferential statistics of the study. To analyse the impact of gait while multi-tasking the factors of velocity and cadence were used. To understand the cognitive impacts of the physical tasks, the dimensions of typing speed (character/min), number of errors, number of characters, and overall time for walking were analysed. Normality of data assessed using the Shapiro-Wilk test (Appendix 2). For the current research, it was decided that a paired sample *t*-test be conducted. This is because the paired-sample *t*-test compares two means that are from the same individual, object, or related units. In this way, the measurement taken is under two different conditions – for the current research, it was a single task and dual tasks. The purpose of the paired sample *t*-test is to determine whether there is statistical evidence that the mean difference between paired observations on a specific outcome is significantly different between zero.

4.1 Descriptive Statistics

The current study had included 16 participants based on the inclusion criteria discussion in the methods of research section. Of the 16 participants in the study, 3 were males while 13 were females. On average, the participants had a height of 1.67 ~~± 0.1~~meters, a weight of 69.5 kg, a BMI of 24.12, and an average age of 31.3 years old. It should be noted that participants had varying ranges of shoe size, however, the average show size of the sample was 6.

4.2 Inferential Statistics

4.2.1 Impact on Velocity of Participants

For this portion of the research, it was essential to comprehend if the mean difference between single tasks and dual tasks were indeed significant, the accumulated data of obtained from GaitRite is in Appendix 1. For this purpose, the paired sample *t*-test was used to analyse the difference in means between cadence and velocity of gait by each of the participants. To conduct the test, the following rules are applicable

- *t*- value: if it is greater than 1.96 then there is statistical significance.
- *p*-value: α value less than 0.05 rejects the null hypothesis, greater than 0.05 accepts the null hypothesis.
- μ_1: is the sample with single tasks
- μ_2: is the sample with dual tasks

When testing velocity, the following hypotheses are formed:

- **H_0: $\mu_1 = \mu_2$ (the paired population means are equal)**
- **H_1: $\mu_1 \neq \mu_2$ (the paired population means are not equal)**

The following results were produced when testing statistical significance for velocity of participants;

Table 1- Paired Sample Test Results- Velocity

Paired Samples Test

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Velocity_ST - Velocity_DT	27.206	15.647	3.912	18.868	35.544	6.955	15	.000

Table 2- Paired Sample Correlations Results- Velocity

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Velocity_ST & Velocity_DT	16	.669	.005

Based on the output obtained and illustrated in table 1, the *t*-value obtained was 6.955 which is greater than 1.96. It is concluded that the test conducted perceives that there is a statistical significance for differences in mean velocity of participants between single tasks and dual tasks. The mean difference in velocity of both these tasks was 27.206 cm/sec. The *p*-value that was resulted from the *t*-paired test is found to be less than 0.05. Therefore, the null hypothesis is rejected and the alternative hypothesis is accepted, which shows that the paired population means are not equal. This can be interpreted as meaning that on average, the velocity of single tasks was 27.206 higher than the velocity of dual tasks at a 95% confidence interval. According to table 2, both velocities of single tasks and velocity of dual tasks are strongly and positively correlated with r= 0.669, *p*=0.005. It is concluded that texting has an impact on the walking of the participants around the circuit lap due to decreased velocity means produced.

4.2.2 Impact on Cadence of Participants

When assessing the impact of dual tasks on cadence the same paired *t*-test was conducted with the following assumptions

- *t*- value: if it is greater than 1.96 then there is statistical significance.
- *p*-value: α value less than 0.05 rejects the null hypothesis, greater than 0.05 accepts the null hypothesis.

- μ_1: is the sample with single tasks
- μ_2: is the sample with dual tasks

When testing velocity, the following hypotheses are formed:

- **H_0: $\mu_1 = \mu_2$ (the paired population means are equal)**
- **H_1: $\mu_1 \neq \mu_2$ (the paired population means are not equal)**

Table 3- Paired Sample Test Results- Cadence

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Cadence_ST - Cadence_DT	7.10625	5.42346	1.35587	4.21629	9.99621	5.241	15	.000

Table 4- Paired Sample Correlations Results- Cadence

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Cadence_ST& Cadence_DT	16	.911	.000

According to table 3, the *t*-value produced was 5.241, which is greater than 1.96 therefore, the difference in means between single tasks cadence and dual-task cadence in participants is statistically significant. Under the assumptions described above, the *p*-value produced for this paired *t*-test is less than 0.05. Hence, the null hypothesis is rejected and the alternative hypothesis is accepted. Based on table 4, the single-task cadence and dual-task cadence are strongly and positively correlated with an $r= 0.911$, $p= 0.00$. There is a significant average difference between single-task cadence and dual-task cadence of 7.106 step/min. On average, single-task cadence was 7.106 steps/min higher than dual-task cadence at a 95% confidence interval.

4.2.3 Impact on Typing Speed of Participants

The participants were also analysed to see if there is a difference in typing speed when carrying out the single and dual tasks. The rules of conducting the paired *t*-test were the same as stated previously in sections 3.2.1 & 3.2.2. The hypotheses developed are as follows:

- **H_0: $\mu_1 = \mu_2$ (the paired population means are equal)**
- **H_1: $\mu_1 \neq \mu_2$ (the paired population means are not equal)**

Table 5- Paired Sample Test Results- Typing Speed

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Baseline_Typing_Speed - DT_Texting_Speed	2.59353	45.19965	11.29991	-21.49166	26.67872	.230	15	.822

Table 6- Paired Sample Correlations- Typing Speed

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Baseline_Typing_Speed & DT_Texting_Speed	16	.793	.000

Based on table 5, the *t*-value produced is 0.230 which is considered to be insignificant because it is less than the value of 1.96. Also, the *p*-value, 0.822 produced is greater than 0.05 which allows the researcher to conclude that the null hypothesis is accepted, and the alternative is rejected. Therefore, it is concluded that the paired population means are equal, there is no significant difference in average texting speed of character/min. That is significant to report is that both baseline typing speed (single-tasks) and dual-task texting speed is strongly and positively correlated with r= 0.793, p= 0.0002.

5 Discussion and Conclusion

Performing multiple tasks simultaneously is often done naturally without much thought and hence establishes a system of attention distribution and which in turn causes difficulty in motor skills such as walking (Jeon et al., 2016). Jeon et al. (2016) stated that if a person's attention is concentrating on one task due to the lack of a well-established strategy, an unexpected situation may arise such as an accident. Gait or walking is considered a form of automatic movement, yet in situations where gait becomes part of a dual-task, less attention is paid to walking and this leads to a reduction in gait velocity and tempo (Li et al., 2018; Liu et al., 2017).

The results of the current study provide evidence that is similar to that of already published research (Kim and Kim, 2018; Yang et al., 2018; Yang et al., 2007). It is found that when dual-tasking of walking and texting are experienced by participants there is a decrease in cadence and velocity. The statistical analysis has provided that the results are statistically significant, meaning they are not based on chance alone and that the factors of dual-tasking are having an impact on the gait of individuals. What is surprising in the current research is that in multi-tasking and single-task the average typing speed of individuals was not statistically significant.

This can be interpreted as meaning that the results were due to chance, or there is a third factor that may influence the typing speeds of individuals. It was found that no mean difference existed for typing speed, this contrasts to Plummer et al. (2015) who found that texting speed significantly decreases dual-tasking performance in healthy young adults. The researchers conclude that another factor may be influencing this cognitive ability, or it can be hypothesised that all participants are very well versed in texting and may focus greatly on their cognitive ability while lacking in their physical ability. This can be interpreted as meaning that cognitive functions may require increased focus compared to physical functions like walking. Therefore, implementing dual-tasking in a rehabilitation setting is optimal as Yang et al., 2007 found the gait speed, cadence, stride time, and stride length were improved after 4 weeks of motor dual-task gait training. Plummer et al. 2014 also reported improvement in gait speed after 12 sessions of cognitive dual-task gait training

The study, however, does encompass certain limitations that make it difficult to implement the results in the general population. Firstly, the sample size of the current study is very small (N=16). Also, the participants of the study had come from diverse backgrounds which may hinder their understanding in participating in the study attributed to factors of being of different nationalities that may make their understanding of the English language difficult. These elements may also impact their gait and texting skills. Furthermore, the study population’s inherent ability to text was not considered in the study. This limits the study’s results in ascertaining if dual-tasking may actually impact gait.

As participants were not instructed to prioritise either talking or texting in dual-tasking. Future research can overcome the limitations of the current study by using a more coherent population with larger sample size. Also, future studies can incorporate the measure of prior texting ability to understand the impact it may have on dual-tasking of gait and texting. It is recommended for future studies to incorporate the analysis of factors such as the speed of texting and the number of errors when dual-tasking. For the stroke population, it will be necessary to investigate whether dual-task training is effective at improving performance in everyday life in stroke patients, and thereby demonstrate whether dual-task performance can help improve task performance in stroke patients.

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7 APPENDIX 1- RAW DATA OF GAITRITE

Subject	Gaitrite outcomes Normal walking: Cadence (step/min)	Velocity (cm/sec)	Stride length (cm)	Stride length variability	Step length (cm)	Step length variability	Double support (%GC)	Single support (%GC)	Stride time (sec)	Stride time variability	Step time (sec)	Step time varibility	Step width (cm)	Step count	overall time of walking
S1	134.1	143.4	128.6	4.1	64.2	4.5	21.8	39.3	0.9	2.0	0.4	2.4	11.5	53.0	2.4
S2	117.7	133.3	136.0	1.6	68.0	1.7	25.6	37.3	1.0	1.8	0.5	2.0	7.5	50.0	2.4
S3	117.9	136.1	138.6	2.9	69.3	3.5	27.8	36.2	1.0	1.4	0.5	2.1	13.6	45.0	2.4
S4	117.8	152.2	155.1	1.5	77.6	1.9	19.5	40.4	1.0	1.5	0.5	1.9	6.8	42.0	2.2
S5	131.1	161.9	148.3	1.6	74.1	2.3	17.5	41.3	0.9	2.2	0.5	2.9	10.7	44.0	2.1
S6	106.7	151.8	170.6	1.7	85.4	2.0	22.6	39.0	1.1	2.3	0.6	2.8	13.5	38.0	2.2
S7	99.8	116.0	135.5	5.5	69.8	5.5	25.7	37.3	1.2	3.1	0.6	3.5	7.9	48.0	2.6
S8	98.4	100.0	122.2	3.1	61.1	3.4	26.7	36.9	1.2	2.1	0.6	2.8	8.6	57.0	3.4
S9	116.2	134.6	139.1	1.7	69.5	2.0	26.9	36.6	1.0	1.6	0.5	2.0	9.0	45.0	2.4
S10	117.6	145.5	148.7	4.4	74.3	4.5	25.3	37.5	1.0	2.3	0.5	2.8	16.4	43.0	3.4
S11	117.5	149.5	152.8	1.7	76.3	1.9	20.2	39.9	1.0	1.2	0.5	1.7	6.1	42.0	2.3
S12	119.1	161.6	162.5	6.1	81.4	6.5	20.4	40.1	1.0	3.7	0.5	4.1	9.9	39.0	2.1
S13	134.9	180.8	160.9	2.5	89.4	2.6	21.1	39.9	0.9	2.7	0.4	3.3	8.3	40.0	1.6
S14	133.2	155.0	139.6	3.6	69.8	3.9	21.5	39.4	0.9	2.0	0.5	2.5	15.2	47.0	2.2
S15	125.2	156.7	150.3	3.3	75.1	3.5	20.4	39.9	1.0	1.5	0.5	2.0	9.2	43.0	2.2
S16	124.6	141.1	136.1	1.7	67.9	2.1	24.3	37.9	1.0	2.3	0.5	2.7	14.7	48.0	2.3
Avg	119.5	145.0	145.3	2.9	73.3	3.2	22.9	38.7	1.0	2.1	0.5	2.6	10.6	45.3	2.4
S.d.	11.1	19.0	13.1	1.5	7.5	1.4	3.1	1.6	0.1	0.6	0.0	0.6	3.2	5.1	0.5

Subject	Gaitrite outcomes DT: Cadence (step/min)	Velocity (cm/sec)	Stride length (cm)	Stride length variability	Step length (cm)	Step length variability	Double support (%GC)	Single support (%GC)	Stride time (sec)	Stride time variability	Step time (sec)	Step time varibility	Step width (cm)	Step count	Texting: Overall time of walking	Number of characters	Numbers of errors	Typing speed (character/ min)	Baseline: Number of characters	Numbers of errors	Typing speed (character/ min)	Randomisation [DT first or N first]	Demographics: Height (m)	Weight (kg)	BMI	Age	Shoe size	Gender	Comments
S1	129.7	130.6	121.0	3.0	60.5	3.3	24.1	38.2	0.9	2.6	0.5	3.4	12.0	50.0	ST	508.0	26.0	212.6	110.0	5.0	220.0	DT	1.6	55.5	22.5	31.0	4.0	F	0.0
S2	104.5	108.9	124.2	6.6	62.5	11.2	27.6	37.0	1.1	6.8	0.6	10.2	7.6	56.0	3.2	297.0	24.0	92.0	66.0	5.0	132.0	DT	1.7	83.2	29.1	26.0	4.0	M	0.0
S3	113.1	110.7	117.6	5.1	58.7	6.3	32.1	33.8	1.1	3.3	0.5	4.3	16.0	58.0	3.2	543.0	19.0	169.7	118.0	3.0	236.0	ST	1.6	87.9	35.6	45.0	5.0	F	0.0
S4	104.1	114.3	132.1	2.9	65.9	3.3	23.9	38.4	1.2	3.0	0.6	3.6	7.6	50.0	3.1	529.0	10.0	170.1	108.0	4.0	216.0	ST	1.7	65.0	22.4	37.0	6.0	F	0.0
S5	133.1	157.4	142.0	4.2	70.9	4.3	18.1	41.1	0.9	2.6	0.5	3.2	11.3	47.0	2.2	515.0	0.0	230.9	126.0	1.0	252.0	ST	1.6	48.3	18.6	29.0	6.0	F	0.0
S6	109.9	148.8	162.4	1.6	81.2	2.0	23.6	38.5	1.1	5.6	0.5	6.0	14.0	41.0	2.3	277.0	0.0	121.5	94.0	0.0	188.0	DT	1.7	86.0	29.1	27.0	8.0	F	0.0
S7	93.1	92.8	119.7	4.7	59.8	5.6	27.2	36.6	1.3	3.0	0.6	4.2	8.2	50.0	3.3	591.0	8.0	176.9	79.0	2.0	158.0	ST	1.7	55.0	20.0	25.0	6.0	F	es during texting task
S8	85.2	75.0	105.6	3.7	52.7	4.2	31.0	34.5	1.4	2.7	0.7	3.6	9.4	67.0	4.6	1217.0	19.0	266.3	133.0	4.0	266.0	DT	1.6	56.3	21.2	27.0	5.5	F	0.0
S9	112.7	120.9	128.8	1.8	64.3	2.4	28.8	35.8	1.1	2.5	0.5	3.0	10.1	51.0	3.1	552.0	5.0	179.8	107.0	0.0	214.0	ST	1.7	85.0	28.4	27.0	8.5	M	0.0
S10	112.9	103.1	109.8	4.7	54.8	5.6	31.5	34.4	1.1	2.4	0.5	3.4	20.1	62.0	2.3	784.0	33.0	345.4	121.0	4.0	242.0	DT	1.7	72.2	25.6	29.0	6.5	F	0.0
S11	109.3	123.4	135.7	2.5	67.7	2.8	24.2	37.9	1.1	1.8	0.6	2.4	6.5	49.0	2.6	726.0	0.0	284.7	131.0	0.0	262.0	ST	1.8	63.6	19.8	31.0	5.0	F	0.0
S12	103.6	111.5	129.5	4.5	64.6	4.9	27.5	36.3	1.2	5.5	0.6	6.1	9.8	54.0	3.1	727.0	47.0	233.0	92.0	5.0	184.0	DT	1.7	61.1	21.9	30.0	7.5	F	0.0
S13	130.7	118.8	144.9	2.3	72.5	2.8	23.2	38.7	0.9	2.5	0.5	3.1	7.4	45.0	2.2	740.0	92.0	344.2	155.0	19.0	310.0	DT	1.7	69.5	24.9	31.0	5.0	F	0.0
S14	121.9	126.1	124.3	4.0	62.1	4.3	24.5	37.8	1.0	3.9	0.5	4.4	17.0	48.0	2.4	515.0	0.0	214.6	93.0	3.0	186.0	ST	1.6	72.3	27.5	35.0	6.5	F	es during texting task
S15	116.0	123.1	127.2	2.2	63.5	2.8	24.2	38.1	1.0	1.5	0.5	2.4	10.5	51.0	3.0	405.0	37.0	134.6	64.0	3.0	128.0	ST	1.7	70.3	24.0	44.0	6.0	F	0.0
S16	118.3	118.8	120.6	2.6	60.2	3.3	26.6	37.0	1.0	3.2	0.5	3.8	15.6	57.0	3.1	551.0	16.0	178.3	101.0	3.0	202.0	ST	1.6	80.8	31.2	28.0	7.0	M	es during texting task
Avg	112.4	117.8	127.8	3.5	63.9	4.3	26.1	37.1	1.1	3.3	0.5	4.2	11.4	52.3	2.9	592.3	21.0	209.7	106.1	3.8	212.3	####	1.7	69.5	25.1	31.4	6.0	####	0.0
S.d.	13.0	19.5	13.9	1.4	6.9	2.2	3.7	1.9	0.1	1.4	0.1	1.9	4.0	6.5	0.6	221.4	23.8	72.9	24.7	4.4	49.5	####	0.1	12.5	4.7	6.0	1.3	####	0.0

8 APPENDIX 2 -DATA DISTRIBUTION ON SPPS

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Velocity (cm/sec)	.144	16	.200*	.954	16	.551
Velocity (cm/sec)	.147	16	.200*	.957	16	.600

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Cadence (step/min)	.196	16	.100	.915	16	.142
Cadence (step/min)	.125	16	.200*	.965	16	.747

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction