



Spatial Navigation: Reliability of the Triangle Completion Task Test in Healthy Adults

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Background

- Spatial orientation is the ability to perceive and integrate self-motion cues provided by the vestibular, visual, and proprioceptive systems to understand one's position and movement in relation to the surrounding environment.
- The Triangle Completion Task Test (TCTT) was developed to test the role of the vestibular system in spatial navigation.
- The Santa Barbara Sense of Direction Scale (SBSDS) was developed to rate self-estimated sense of direction.

Purpose

- The purpose of this observational study was to determine reliability of the TCTT and to compare the relationship between self-estimated sense of direction and performance on the TCTT.
- The hypothesis was that the TCTT would demonstrate a high interrater and test-retest reliability and the SBSDS and TCTT would demonstrate a positive relationship.

Methods

Table 1 – Study Flow

Enrollment	16 healthy adult participants
Screening – Week 1	Sensory – myofilaments Strength – manual muscle test and 5x sit to stand Mobility – 10 Meter Walk Test and Custom Clinical Turning Course (Complete 3 types of turns without and with dual tasking.)
Testing - Week 1, 2	Week 1 – TCTT Rater 1 only Week 2 – TCCT Rater 1 and 2 both

TCTT (Figure 1) - Individual walks a triangular shaped trajectory to a given target, first with visual, auditory, and tactile cues and then with tactile cues only. Participants navigated 4 conditions.

- Condition 1: Long leg – right turns (AB – BC – CA)
- Condition 2: Long leg – left turns (AB – BD – DA)
- Condition 3: Short leg – right turns (DB – BA – AD)
- Condition 4: Short leg – left turns (CB – BA – AC)

Measurements to determine path deviation (Figure 1).

- Final end point – point equal distance between medial malleoli.
- Angular rotation error - angular difference between the participant's final and expected end-point.
- End point error - distance between the participant's final and expected end-point

Instrumentation. Final end point marked with a sticker placed on the floor. Measurements calculated (Figure 2).

- Angular rotation error measured with goniometer and string.
- Endpoint error measured with tape measure.
- Digital photo taken depicting participant's final end point and expected end point.

Figure 1. Schematic Triangle Completion Task Test.

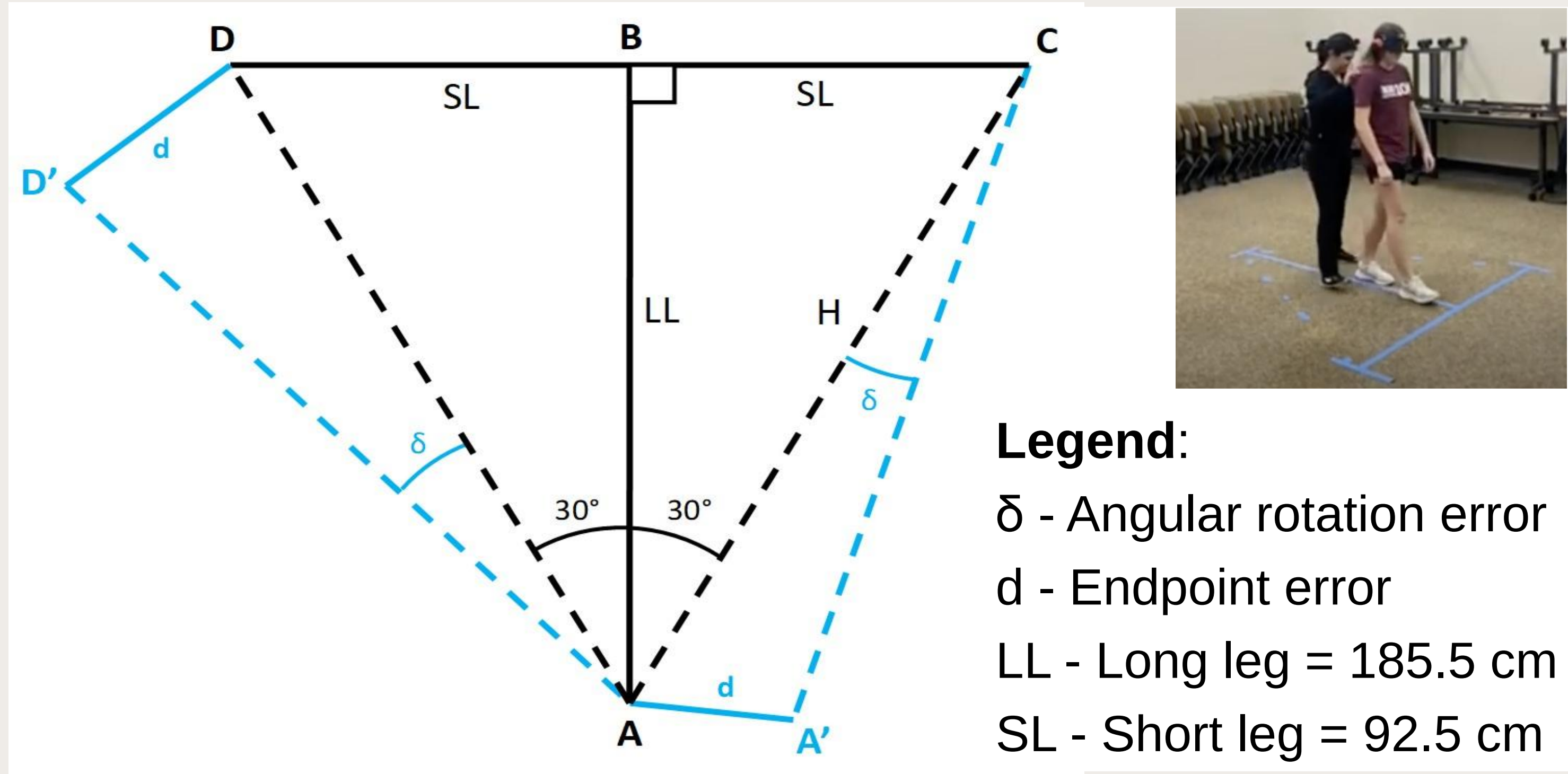


Figure 2. Measuring angular rotation error and end point error.



Statistical Analysis:

- Descriptive statistics performed using Microsoft 365 Excel.
 - Sample demographics
 - Screening components
- Intraclass Correlation Coefficient (ICC) performed using IBM SPSS Statistics 25.
 - Test-retest reliability: ICC (3,1)
 - Interrater reliability: ICC (2,1)
- Spearman Rho Correlation (Rs) performed using IBM SPSS Statistics 25.
 - Relationship between SBSOD & end point error
 - Relationship between SBSOD & angular rotational error

Results

Table 2 – Sample Description

Sample size	16
Age (years)	26.8(+8.3)
Female, n (%)	10(62.5)
SBSDS (median;range)*	4.13(1.93-5.87)

*Santa Barbara Sense of Direction maximum score 7.
Sample means and standard deviations are reported (M $\pm$ SD)

- Fair self-estimated sense of direction reported by majority of participants (Table 2).
- Test-retest reliability was poor for all conditions, ICC(3,1)=-0.46(95% CI: -0.77, 0.03) to ICC(3,1) = 0.47 (95% CI: -0.02, 0.78).
- Interrater reliability was poor to moderate, ICC(2,1)=0.01. (95% CI:-0.48, 0.49) to ICC(2,1)=0.66 (95%CI: 0.26, 0.87).
- Relationship between the SBSOD and TCTT scores was low to fair for most conditions (p=0.05).

Table 3. Reliability of angular rotational error and end point error for all conditions of the triangle completion task.

Condition			Angular Rotational Error		End Point Error	
Number	1st Leg Length	Direction of Turn	ICC (3,1) [95% CI]	ICC (2,1) [95% CI]	ICC (3,1) [95% CI]	ICC (2,1) [95% CI]
1	Long	R	0.09 [-0.41, 0.55]	0.13 [-0.33, 0.57]	0.20 [-0.31, 0.62]	0.19 [-0.37, 0.62]
2	Long	L	0.37 [-0.13, 0.73]	0.01 [-0.48, 0.49]	0.47* [-0.02, 0.78]	0.05 [-0.49, 0.53]
3	Short	L	0.34 [-0.17, 0.71]	0.66* [0.26, 0.87]	0.32 [-0.19, 0.70]	0.65* [0.26, 0.86]
4	Short	R	-0.07 [-0.54, 0.43]	0.12 [-0.43, 0.58]	-0.46 [-0.77, 0.03]	0.14 [-0.41, 0.60]

* Indicates moderate reliability (Portney, 2020)
Abbreviations: R, right; L, left.

Conclusion

- Spatial navigation is a complex cognitive process requiring the ability to perceive and integrate self-motion cues.
- Results suggest that the TCTT may assess a different aspect of spatial ability and not spatial navigation.
 - Reliability of measuring path trajectory with the TCTT was poor.
 - Relationship between self-estimated sense of direction (SBSOD), and path deviation (TCTT) was low to fair.
- Variability in the timing of providing consistent tactile cues may contribute to difficulty maintaining path trajectory.

References

- Hegarty M, Richardson AE, Montello DR, Lovelace K, Subbiah I. Development of a self-report measure of environmental spatial ability. *Intelligence*. 2002;30(5):425-447.
- McLaren R, Chaudhary S, Rashid U, Ravindran S, Taylor D. Reliability of the triangle completion test in the real-world and in virtual reality. *Front Hum Neurosci*. 2022;16:945953.