Characterizing Postural Stability During Smartphone Use on Dynamically Unstable Environments

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Research Questions

Smartphone Impact (Q1): How does smartphone usage impact postural balance and does this relationship change under different environments?
Environmental Impact (Q2): How do varying environmental conditions impact postural balance?

Instrumentation

- A **dual-axis robotic platform** was used to simulate the compliant and oscillatory environmental conditions
- A **customized smartphone** box to detect completion of smartphone task
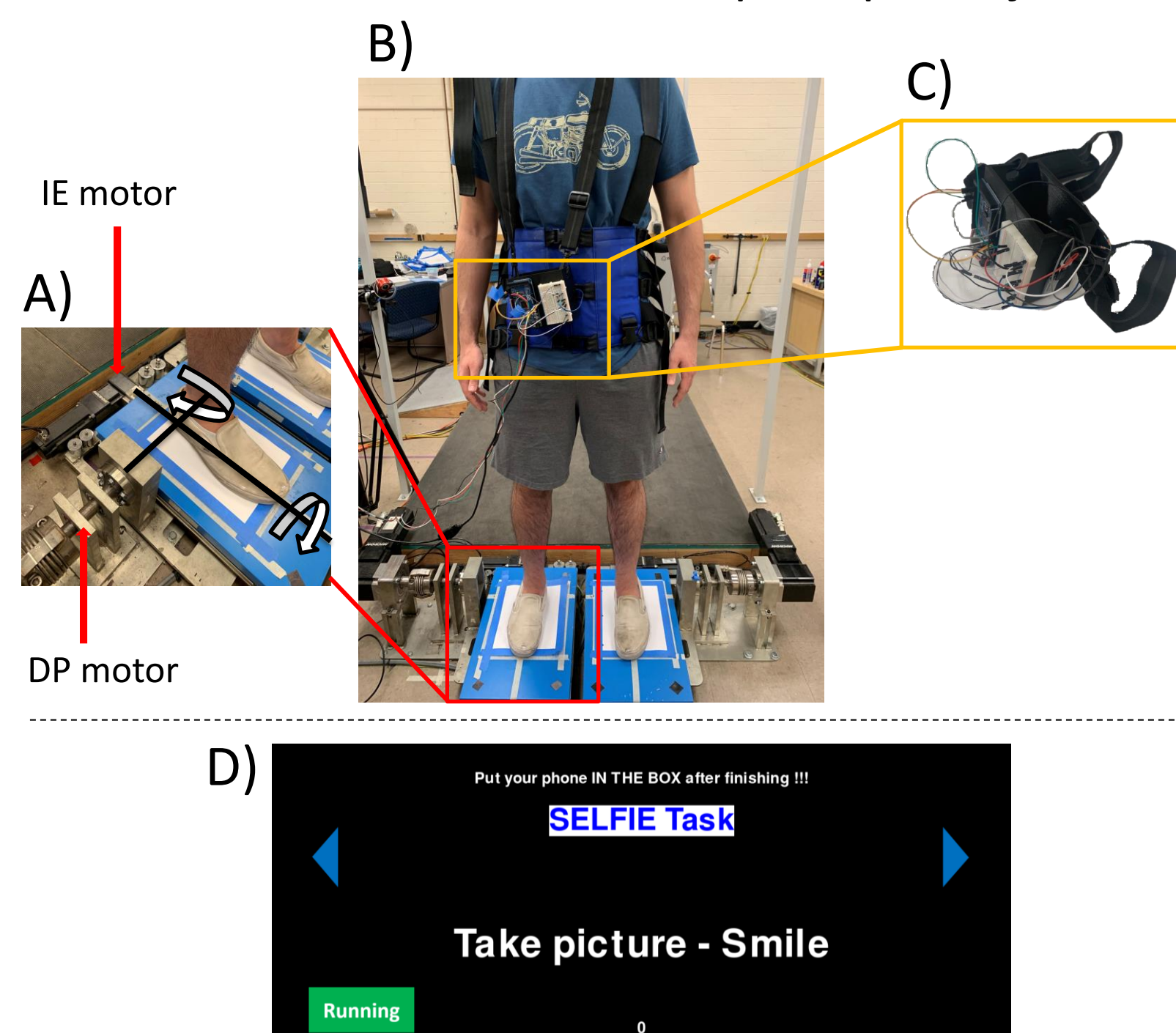- **Visualization monitor** to prompt subjects

Fig. 1. A) and B) show dual-axis robotic platform for environmental simulation, C) smartphone box for detection of task completion, and D) visualization screen to prompt subjects

Methodology

Notation:
- AP – anterior-posterior
- ML – medio-lateral
- IE – inversion & eversion
- DP – dorsiflexion & plantar flexion
- BC – boundary contact
- COP – center of pressure
- SW – switching rate
- VTC – virtual time-to-contact

- Ten healthy, young subjects were recruited for this study
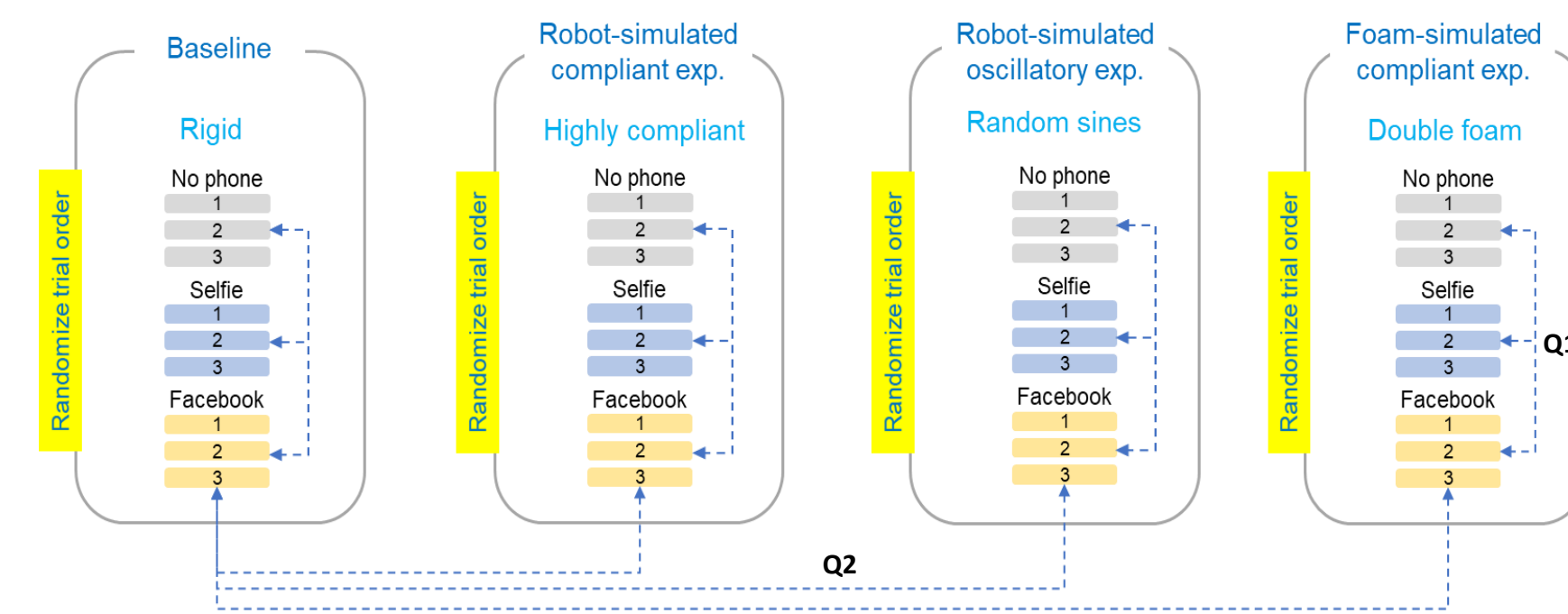
Fig. 2. Experimental protocol used in this study

VTC is defined as the time until the subject's COP touches their base of support boundary. **VTC** in the 2-dimensional plane was calculated with the following formula:

$$\vec{p}_i(\tau) = \vec{r}(t_i) + \vec{v}(t_i) * \tau + \vec{a}(t_i) * \frac{\tau^2}{2}$$

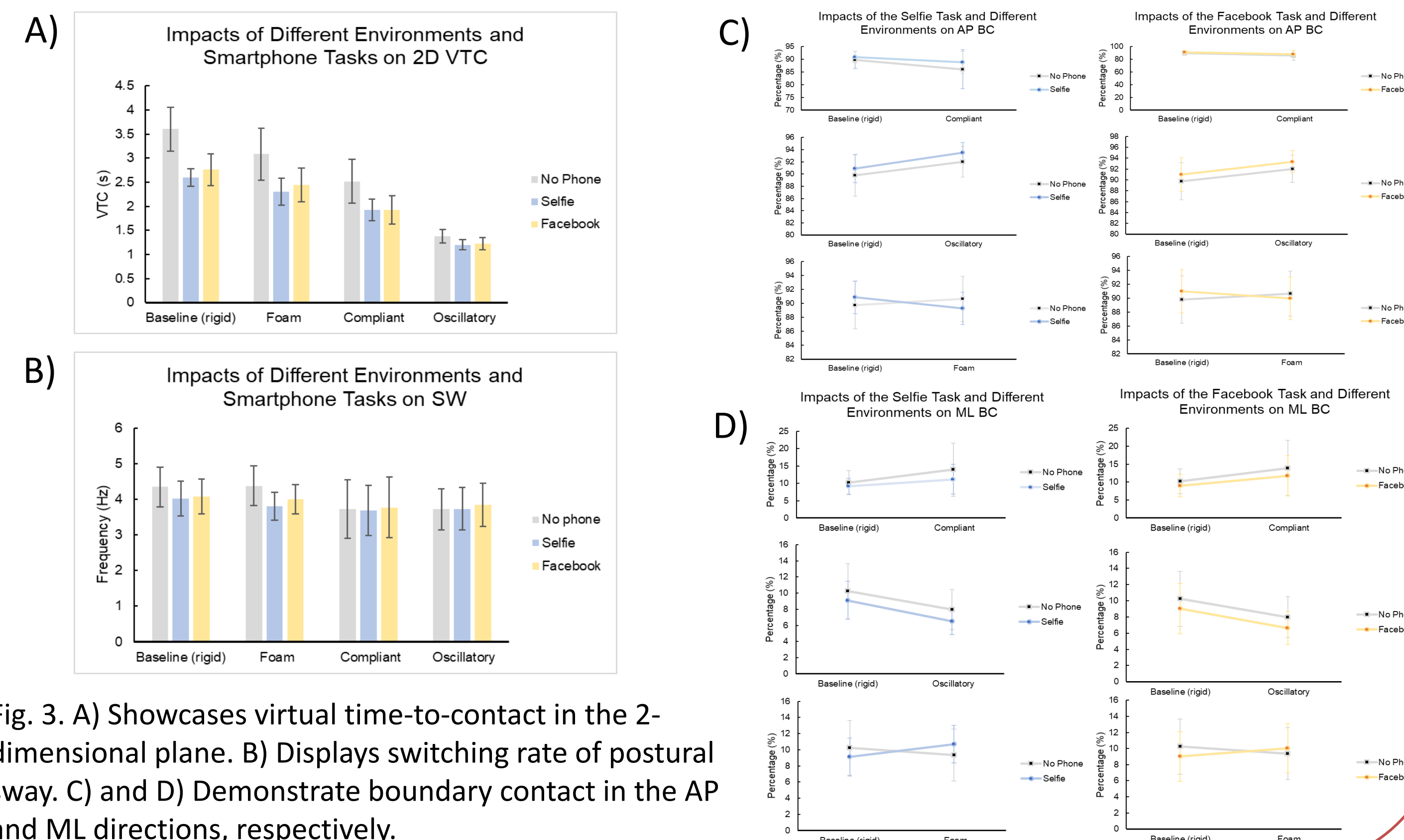A **VTC** time series was calculated and averaged for each trial.

Results

Fig. 3. A) Showcases virtual time-to-contact in the 2-dimensional plane. B) Displays switching rate of postural sway. C) and D) Demonstrate boundary contact in the AP and ML directions, respectively.

Conclusion

- Decreased VTC **within** each environmental condition showed smartphone usage worsened postural stability. Decreased VTC **between** environments suggests that all tested environments worsened postural stability.
- Until subject pool is expanded, current results suggest environment and smartphone tasks had little effect on switching rate.
- Majority of boundary contact is in the AP direction. Oscillatory environments showed larger BC in the AP direction, while a compliant environment showed increased BC in the ML direction. These relationships is more distinct with smartphone usage. The foam environment displayed increased BC when performing a smartphone task.

Future Work

- Expanding the subject pool to include elderly and those with neurological conditions such as multiple sclerosis
- Increasing the sample size of the data
- Possibly incorporate other modern-day smartphone tasks, such as navigation or film-watching

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