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| Research Article

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Effects of Vr and Ice-Based Reaction Drills on Motor Preparedness of Young Hockey Players

Sh. S. Khojiev
Independent researcher, Uzbek State University of Physical Education and Sports, Chirchik city, Uzbekistan

Abstract: This article explores the impact of virtual reality (VR) exercises and ice-based reaction drills on the motor preparedness of young hockey players aged 9–10. A six-week training protocol incorporating VR-based sensory training (Meta Quest Pro), interactive drills (NHL Sense Arena, Hockey VR), and traditional ice-based reaction and agility tasks using React-Light sensors was implemented. The experimental group (n = 15, HC "Snejniy Bars") was compared to a control group (n = 15, HC "Binokor-2"). Statistically significant improvements were observed in the experimental group in terms of dynamic reaction speed, movement precision, and on-ice directional change, affirming the efficacy of combined immersive and applied training methods.

Keywords: virtual reality, ice hockey, youth athletes, motor skills, reaction, sensor-based testing.

Introduction

Modern training of young hockey players requires effective tools for developing motor responses, coordination, and decision-making speed under game conditions. Virtual reality (VR) and sensor-based technologies offer promising tools for improving sensory-motor readiness, particularly at the early training stages. This study investigates the effectiveness of combining VR scenarios and light-based on-ice agility drills to enhance the motor preparedness of hockey players aged 9–10 years.

Materials and Methods

Participants. 30 young hockey players aged 9–10 participated in the study. The experimental group (EG) consisted of 15 athletes from HC "Snow Bars" (Tashkent), and the control group (CG) included 15 athletes from HC "Binokor-2" (Tashkent).

Equipment.

- **VR platform:** Meta Quest Pro with NHL Sense Arena, Pick-up League Hockey, and Hockey VR applications.
- **Ice drills:** React-Light system (RGB-LED sensors), configured for 0.5–8 sec random activation.

- **2D video analysis:** Kinovea v.0.9.6 used to time 20-meter sprints and turning drills on ice.

Testing protocol:

- **VR visual-motor test (NHL Sense Arena):** players responded to visual stimuli with stick input. Reaction time and accuracy were recorded.
- **Skating coordination (Pick-up League Hockey):** players performed zig-zag skating drills; average speed and collision errors were tracked.
- **Turn and positioning test (Hockey VR):** 180° reorientation in simulated game settings; measured by turn execution time and positional precision.
- **Control group:** trained using traditional drills without VR exposure.

Statistical analysis. Pre and post-intervention data were analyzed using paired t-tests. Statistical significance was set at $p < 0.05$.

Results

Table 1. Visual-Motor Reaction Test (NHL Sense Arena)

Parameter	Group	Pre (M ± SD)	Post (M±SD)	Δ	p
Reaction time (ms)	EG	412 ± 38	377 ± 32	–35	p < 0.05
	CG	410 ± 41	403 ± 39	–7	p > 0.05
Reaction accuracy (%)	EG	78.4 ± 6.2	84.9±5.3	+6.5	p < 0.05
	CG	78.0 ± 6.5	79.2±6.4	+1.2	p > 0.05

Participants in the experimental group significantly reduced their average reaction time by approximately 8% and improved their response accuracy by 6.5 percentage points. These enhancements indicate improved visual-motor integration through VR training. The control group did not demonstrate statistically significant changes.

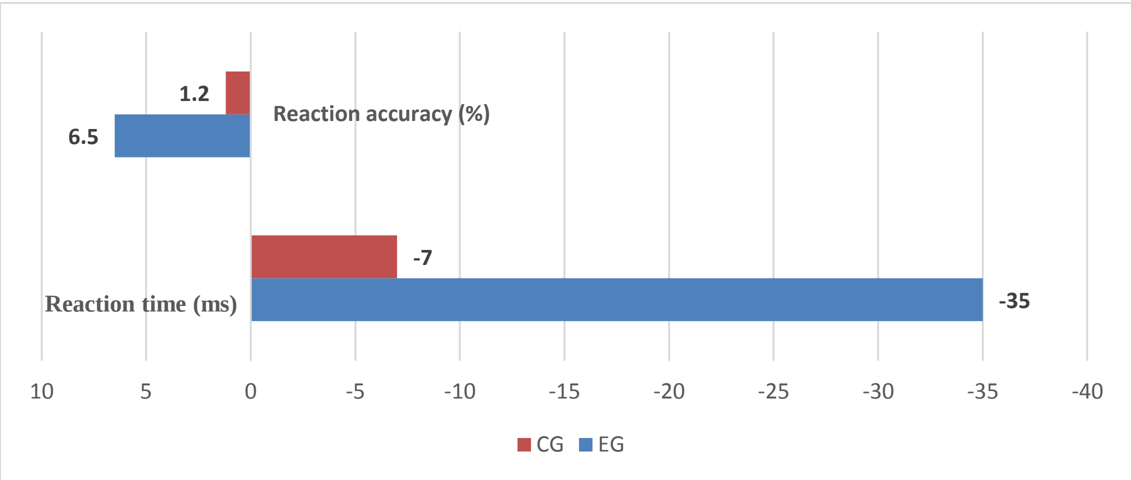

Figure 1. Dynamics of group comparisons (CG &KG) in the Visual-Motor Reaction Test (NHL Sense Arena)

Table 2. Zig-Zag Skating Control (Pick-up League Hockey)

Parameter	Group	Pre (M ± SD)	Post (M ± SD)	Δ	p
Average speed (km/h)	EG	12.8 ± 1.3	13.9 ± 1.1	+1.1	p < 0.05
	CG	12.9 ± 1.4	13.1 ± 1.2	+0.2	p > 0.05

Collision rate (%)	EG	4.1 ± 1.7	2.9 ± 1.3	–1.2	p < 0.05
	CG	4.0 ± 1.8	3.7 ± 1.6	–0.3	p > 0.05

The experimental group showed an increase in skating speed by ~9% and a 30% reduction in cone collisions, suggesting better coordination and movement control. Changes in the control group were minimal and not statistically meaningful.

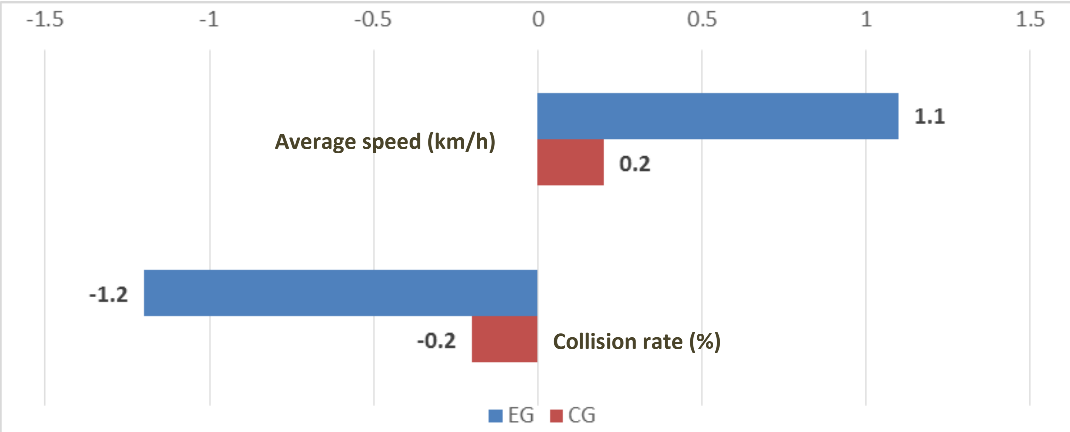

Figure 2. Dynamics of group comparisons (CG &KG) in the Zigzag Skating Control test (Pick-up League Hockey)

Table 3. 180° Turns and Positional Reorientation (Hockey VR)

Parameter	Group	Pre (M ± SD)	Post (M ± SD)	Δ	p
Turn time, 180° (sec)	EG	1.87 ± 0.16	1.68 ± 0.14	–0.19	p<0.05
	CG	1.88 ± 0.15	1.83 ± 0.16	–0.05	p>0.05
Positional accuracy (%)	EG	71.2 ± 7.4	78.5 ± 6.8	+7.3	p<0.05
	CG	72.0 ± 7.1	73.4 ± 7.0	+1.4	p>0.05

After six weeks, the experimental group performed 180° turns ~10% faster and improved positional accuracy by 7.3 percentage points. No significant progress was observed in the control group.

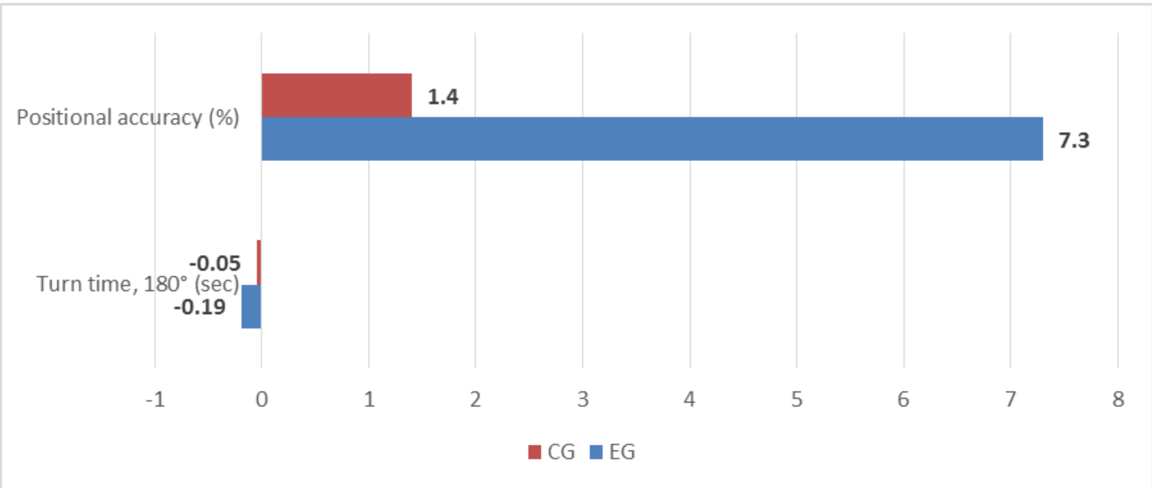

Figure 3. Dynamics of group comparisons (CG &KG) in the 180° Turns and Positional Reorientation test (Hockey VR)

Discussion

The integration of VR exercises and ice-based sensor drills produced measurable improvements in motor performance among the experimental group. The increase in correct light-response cycles confirms the improvement in visual-motor reaction, consistent with studies on immersive feedback systems [Camomilla et al., 2018, p. 25].

Ice testing results confirmed that reaction-based directional training improved both sprint acceleration and agility. The 0.35-second improvement in 20-meter sprints and near-2 additional correct defensive turns confirm the method's practical effectiveness. These changes were not observed in the control group.

The data support the use of VR and light-sensor systems as an integrated tool for reaction training in youth hockey at the early stage of sports development.

Conclusions

1. VR-based feedback systems significantly enhanced reaction time and coordination in young hockey players.
2. React-Light drills enabled functional assessment and improvement of agility and quick directional response on ice.
3. Statistically significant differences between experimental and control groups validate the training methodology.
4. The combined use of immersive and traditional drills can modernize motor training practices in sports schools.

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