Exploring the Impact of Virtual Reality Interventions on Autonomic Arousal in ICU Patients

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Introduction

- The intensive care unit (ICU) poses significant challenges for critically ill patients, often resulting in physical discomfort, psychological stress, anxiety, and depression.
- Immersive virtual reality (VR) has emerged as a promising intervention to address these challenges, offering potential benefits in physical and cognitive rehabilitation, pain alleviation, and mood enhancement.
- This study explores the therapeutic effects of VR on ICU patients, focusing on its impact on autonomic nervous system activity, assessed through electrodermal activity as a marker of stress response.

Methods

Recruitment

- Participants were recruited from two ICUs, with eligibility criteria including ICU admission, ability to consent, and absence of delirium.
- Patients with severe sensory impairments, isolation precautions, or non-invasive nasal masks were excluded.

Data Collection

- Participants chose one of three VR experiences, viewed via Meta Quest Pro headsets, with electrodermal activity (EDA) recorded using Biopac MP150.
- A 5-minute baseline preceded a 5–15-minute VR session, followed by 5 minutes of post-intervention monitoring.
- Signals were preprocessed in MATLAB using artifact correction, filtering, detrending, and normalization.
- Skin conductance responses were analyzed for amplitude and timing during baseline and VR exposure.

Results

Study Participants

- N = 19

Recruitment

- Statistical analysis revealed significant changes in EDA following the VR intervention.
- Post-VR EDA values exhibited increased variability, with significant group-level differences between baseline and post-VR conditions ($p < 0.05$).
- Skin conductance response metrics showed a significant change in parasympathetic nervous system activity, confirmed by paired t-tests ($p = 0.0006$), Wilcoxon tests ($p = 0.0010$), and linear mixed-effects models ($p = 0.0318$).
- These results highlight the potential of VR to modulate physiological arousal in ICU patients.

StudyID	Baseline_Mean	Baseline_StDev	PostVR_Mean	PostVR_StDev	P_Value	Significant
P1	-0.0133	0.0000	0.3575	0.1225	NaN	NaN
P2	1.5430	0.7041	-0.7191	0.8281	0.0000	Yes
P3	0.3704	0.4174	-0.2383	0.0136	0.0732	No
P4	0.8895	0.8148	0.8444	0.9754	0.4718	No
P5	0.4794	1.1146	0.6513	0.9383	0.0060	Yes
P6	1.0050	0.8833	0.6011	0.8762	0.0000	Yes
P7	-0.8418	0.3438	1.4590	1.4505	0.0000	Yes
P8	-0.7250	1.7262	-0.1488	0.2281	0.0227	Yes
P9	0.1231	0.4495	0.0070	0.1162	0.5232	No
P10	0.7265	0.2039	-1.1027	2.1648	0.0000	Yes
P11	1.3037	0.0000	-0.0794	0.0000	NaN	NaN
P12	-2.1851	2.6129	0.9127	0.1318	0.0715	No
P13	2.1686	0.3363	-1.2457	0.1691	0.0000	Yes
P14	1.3658	0.0216	0.7461	0.1786	0.0110	Yes
P15	-1.0812	3.4497	0.5688	0.0000	NaN	NaN
P16	0.6551	0.7883	0.9154	0.8108	0.0000	Yes
P17	0.2361	0.4377	-0.0011	0.2758	0.5788	No
P18	1.4662	0.8750	0.4374	0.3939	0.0350	Yes
P19	-0.0522	0.8527	-0.4624	0.1686	0.0140	Yes

Figure 1. Paired Samples T-Test Results



Figure 2. Experimental Setup

Discussion

- This study demonstrates that immersive virtual reality (VR) can significantly influence autonomic nervous system activity in ICU patients, as evidenced by changes in electrodermal activity and skin conductance responses ($p < 0.001$).
- These findings suggest that VR effectively engages the parasympathetic nervous system, addressing stress and sensory deprivation inherent in ICU settings.
- Future research should focus on optimizing VR interventions and evaluating their long-term benefits in critical care environments.

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