【Grant-in-Aid for Transformative Research Areas（B）】

Manipulation of the Umwelt through the use of sound

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Project Information	Project Number : 24B402 Project Period (FY) : 2024-2026
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Purpose and Background of the Research

● **Outline of the Research**

< **Utilizing the ambiguity of sound cognition to construct better individual world perceptions** >

The goal of this research is to transform the method of manipulating the world perception through sound, focusing on auditory information which, despite its ambiguity, serves as a gateway to perceiving the world. Sound significantly contributes to the formation of each person's unique sense of the world, or "Umwelt" (Uexküll, 1934), by linking to specific memories. Although sound is widely used in various fields including medicine, the inherent ambiguity of sound cognition and the differing Umwelts it creates for individuals are often overlooked. This research brings together experts in the process of forming Umwelts through sound, PTSD clinical specialists, and experts in memory manipulation using sound during sleep, to initiate transformative changes in manipulating Umwelts using sound. This will enable the easy normalization of distorted Umwelts caused by illnesses, creating a future where sound restores normalcy.

The research focuses on PTSD (Post-Traumatic Stress Disorder), where changes in the Umwelt are particularly clear, considering the research team's achievements, uniqueness, and novelty.

The team has previously met physicians' requests by producing 3D audio stimuli for PTSD treatment. The ability to create appropriate 3D audio stimuli without detailed knowledge of the traumatic event is underpinned by the ambiguity of sound perception, which tolerates positional discrepancies and timbral differences better than vision, as suggested by previous studies by Zempo (acoustic/information engineering), Ino (clinical medicine/physician), and Sakaguchi (neuroscience/physician). Recent advancements in virtual reality (VR) technology and generative AI have led to the conception that Umwelt manipulation is feasible.
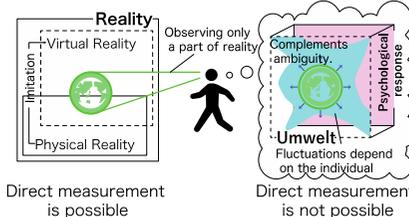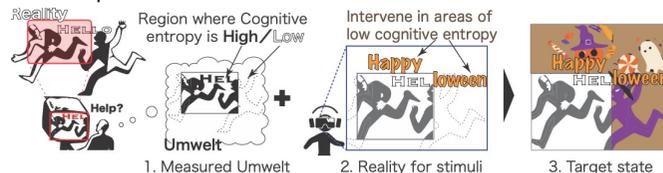

Fig. Umwelt is a biological concept that indicates the environment that organisms can perceive and interact with directly through their sensory organs. Here, it represents the world based on individual perception and memory. Umwelts are formed by supplementing missing areas of observed reality, a process that is ambiguous and varies from person to person.

Fig. Manipulating individual world perceptions by intervening in unobserved areas (Umwelt manipulation).

● **Research Teams and Their Objectives**

This area is defined with PTSD treatment as the primary application, advancing the following three researches:

A01 Team: Methodology for Manipulation Using Umwelt and Sound Cognition Ambiguity

By utilizing speech recognition AI, interactive AI, and generative AI, the normally unobservable individual Umwelts are digitized in VR spaces, and by defining the ambiguity in each area, foundational methods for cognitive transformation and intervention using sound are explored.

A02 Team: New Developments in PTSD Treatment Using Virtual Reality Exposure

Using the methods of sustained exposure therapy, an effective cognitive-behavioral treatment for PTSD, this team will test if anxiety can be alleviated by repeatedly exposing patients to sound stimuli they have attributed meaning to, thereby developing new treatment modalities.

A03 Team: Umwelt Manipulation Using Sound Stimuli During Sleep

Led by A03, with technical support from A01, this team will elucidate the effects of Umwelt manipulation using sound stimuli during sleep and advance sleep research, contributing to the development of treatments for sleep-related disorders and diseases.

Expected Research Achievements

● **Goals of the Entire Research Area**

During the research period, by achieving the following goals through the three teams, a foundation for Umwelt manipulation will be established that can be extended to PTSD treatment and various other fields.

Foundation of Umwelt Research:

Teams collaborate to develop the computational theories, hardware, and software necessary for measuring and intervening in Umwelts, establishing a research foundation.

Applied Research in Sound Systems:

Together, the teams will advance the development of methods for manipulating Umwelts using sound systems and study the effects of sound, contributing to improved interpersonal relations and information presentation in real and virtual spaces.

Umwelt Manipulation Research Using Sound During Sleep:

A03 leads in exploring the effects of Umwelt manipulation during sleep, contributing to the progression of sleep research and the development of treatments for sleep-related disorders.

● **Impacts**

By establishing methods for Umwelt manipulation through sound in this research area, natural and subtle Umwelt manipulations will be realized, pioneering the field of interaction design utilizing the ambiguity of Umwelts. This opens up possibilities in interaction design, support for physical disabilities, literacy, cultural comparison, and media art.

Specifically in the medical field for PTSD treatment, the following two outcomes are anticipated:

1. Using VR technology, the already proven effective sustained exposure therapy can be developed into a new treatment that is less burdensome, more effective, and applicable to challenges that are difficult to address in reality (e.g., flying on an airplane, approaching a beehive), enabling patients to undertake tailored treatments quickly and anywhere.

2. Proposing a new paradigm for PTSD treatment, a revolutionary approach through sound stimuli during sleep that suppresses fear responses, reducing the mental burden experienced by patients during treatment and enabling broader social applications.

Homepage Address, etc.	https://umwelt.iit.tsukuba.ac.jp