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Research Article

Visual and auditory stimulation for patients in the intensive care unit: A mixed-method study

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ABSTRACT

Objectives: To determine what type (e.g., television, photographs, music, etc), content (e.g., nature scenes, family members, etc), and duration of visual and auditory stimuli should be provided to intensive care unit patients during their hospitalisation.

Research methodology and design: This mixed-methods study followed an exploratory-descriptive design. In total, 31 participants were interviewed: 19 were former critically ill patients in the intensive care unit and 12 were nursing experts, all from a university hospital in Switzerland. Based on current practice, patients and nurses were familiar with receiving and providing television, photographs, radio, and musical stimuli, with no specific exposure to virtual reality, aside from that in their personal lives. Data were collected from the former patients using structured interviews, whereas semi-structured interviews were used for the nursing experts.

Findings: Overall, patient and expert opinions aligned well; both groups agreed that receiving visual and/or auditory stimuli would benefit patients. Photographs, television, and virtual reality were the visual stimuli most chosen by the patients, with an emphasis on nature-focused content. When appropriate, audio matching the content should be provided alongside the visual stimuli to act as a distraction from the hospital environment. Visual stimuli should not exceed 10–15 min, while auditory stimuli should not exceed one hour.

Conclusion: Sensory overload and deprivation are common problems in the intensive care unit with negative effects on patient outcomes. Based on patient and expert opinions, visual and auditory stimuli are desired by patients and could help address these issues.

Implications for clinical practice

- Nurses should be aware of what type of stimuli (visual and/or auditory) and content may be desired by patients in their care.
- Nurses should offer photographs, television, and virtual reality, with audio matching the video content, to patients to improve the patient's moods or to provide a distraction.
- The duration of visual stimuli should be approximately 10–15 min, while auditory stimuli should not exceed one hour.

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Introduction

Every year, approximately-five million patients are admitted to the intensive care unit (ICU) in the United States alone (Barrett et al., 2006; Young and Birkmeyer, 2000). While many admissions to the ICU may be planned for example, as part of post-surgery care others result from an unexpected event. When planned, individuals may prepare themselves via the internet or pamphlets for what to expect in the ICU and can express their needs and preferences for improving their psychological wellbeing. However, in the case of unexpected admissions, there is no way for individuals to prepare themselves for this experience, making it difficult to know what they desire for their wellbeing. Consequently, critically ill patients often experience a great deal of stress while in the ICU outside of their reason for admission (Krampe et al., 2021). A systematic review by Krampe et al. (2021) grouped stressors in the ICU into four categories: physical, mental, communicative, and environmental. While the first three categories are patient-, diagnosis-, and treatment-dependent, the fourth category, environment, is independent of these factors.

Specifically, one factor leading to stress in critically ill patients is their exposure to multimodal stimuli in their immediate surroundings, such as noises, lights, smells, and temperatures among other factors (Gultekin et al., 2018; Krampe et al., 2021). The amount of sensory input a patient receives is an important component of their care (Stuart, 2014). On the one hand, critically ill patients may be overwhelmed by the presence of alarms and activity around them (Tronstad et al., 2021). This phenomenon is known as sensory overload and has been linked to negative health outcomes such as the development of delirium (Stuart, 2014; Tainter et al., 2016). On the other hand, critically ill patients may require medical isolation, resulting in loneliness and a lack of stimulation (Stuart, 2014). Too few stimuli, known as sensory deprivation, can also lead to health problems such as hallucinations (Leach, 2016, Stuart, 2014). Environmental and architectural factors in the hospital play an important role in shaping patients' sensory environment and determining whether a patient is at risk of experiencing either too much or too little stimulation (Holm and Dreyer, 2017; Leach, 2016; Stuart, 2014; Tronstad et al., 2021; Verderber et al., 2021). Other factors related to patient treatment, such as intubation, also increase the risk of sensory overload or deprivation as the patient is unable to communicate their desires (Krampe et al., 2021).

To overcome the lack of stimulation and better orient existing stimuli, nurses, and other healthcare professionals, such as occupational therapists, have begun utilising certain types of visual and auditory stimuli in clinical practice. For example, television (Bazuin and Cardon, 2011), virtual reality (Gerber et al., 2017; Jawed et al., 2021), and music (Cooke et al., 2020; Stichler, 2001) are used to stimulate these patients while they are in the ICU. However, it is unclear what type of stimulation (e.g., photographs, picture books, television, virtual reality, etc.) and content (e.g., nature versus city scenes) are most appropriate.

Due to the negative associations and outcomes linked to the patient environment in the ICU, it is problematic that there still exists a lack of information specifically examining ways in which sensory input is currently being addressed in this setting. There is no clear understanding of what stimuli critically ill patients would enjoy experiencing or what type of stimuli could have a beneficial effect on these patients. This lack of understanding, and the consequent gap in the literature, results in the implementation of stimulus preferences that are already a part of standard care, but these may not always be adequate. The goal of this study is to determine, based on the opinions of both experts and patients, the optimal type, content, and duration of stimuli for ICU patients during their hospitalisation in ICU based on the opinion of experts and patients. The study has two main aims: firstly, to investigate what type and duration of stimuli former critically ill patients would have enjoyed receiving; and secondly, to examine what type of stimuli critical care nurses believe would benefit patients.

Methods

Study design

This study followed a mixed-method design. This consisted of quantitative data collection via structured interviews using a questionnaire for former ICU patients, and qualitative data generated from open-ended questions from semi-structured interviews with expert nurses (EN). Data was collected from the two groups in parallel, with the interviews being part of an intervention development for a randomised controlled trial (Naef et al., 2021). A convergent design was subsequently used to simultaneously integrate the two types of data at the data collection and analysis level. This approach allowed common concepts to be concurrently identified and compared across the quantitative and qualitative results (Creswell and Clark, 2017).

Participants and setting

This study was conducted in a university hospital's mixed ICU in the German-speaking area of Switzerland (Fig. 1). The ICU is made up of four single-bed rooms, six two-bed rooms, and four four-bed rooms. Half of the rooms contain windows. Patients do not have control of the lights; however, the lights are dimmed in the evening and at night whenever the patients' conditions allow it. During the day, doors are kept open as often as possible but may be closed at night so as not to disturb the patients.

The study included a convenience sample of 31 participants, of which 19 were former critically ill patients and 12 were nursing experts, made up of a combination of critical care nurses and advanced practice nurses. Patient participants were required to be German- or French-speaking, be at least 18 years of age, and have been hospitalised in the ICU for more than 24 h. The patient participants represented a range of medical diagnosis groups, including trauma, neurosurgical, and other surgical types. Among the nursing experts, interviewees included critical care nurses with two years further education in intensive care following their bachelor's degree and/or master's degree and two years of professional work experience. The study team required a minimum work experience of two years to ensure that nurses participating in the study had experience working directly with patients. Participation in this study was voluntary. All participants were informed of the study either via email or verbally and were asked whether they were willing to take part in the study. Participation in the interview confirmed the participants' consent to the study.

Data collection

Recruitment of former critically ill patients took place verbally during a standard ICU follow-up between September 2019 and September 2021. The follow-ups are part of standard practice for patients who spent time in the ICU at the hospital in which the study was conducted. All patients who participated in the follow-up were asked if they were willing to participate in this study. While the COVID-19 pandemic hindered the recruitment process for the study, it did not influence how the interviews were conducted. During this same period, nursing experts were recruited for participation via email. All interviews took, at most, one hour to complete. To describe the two study groups, demographic data such as age, sex, and education level was collected during the interview. The reason for the ICU stay (for example, illness or accident) and work experience were also collected from the patients and nurses, respectively.

To conduct the interviews, the study team developed questions based on the literature and clinical expertise (Luetz et al., 2019, Minton et al., 2018, Nin Vaeza et al., 2020). All former patients were asked the same questions via a structured interview in which they were asked to rank their order of preference for the given questions (Supplementary Table S1). Individual ranking scales varied depending on the question

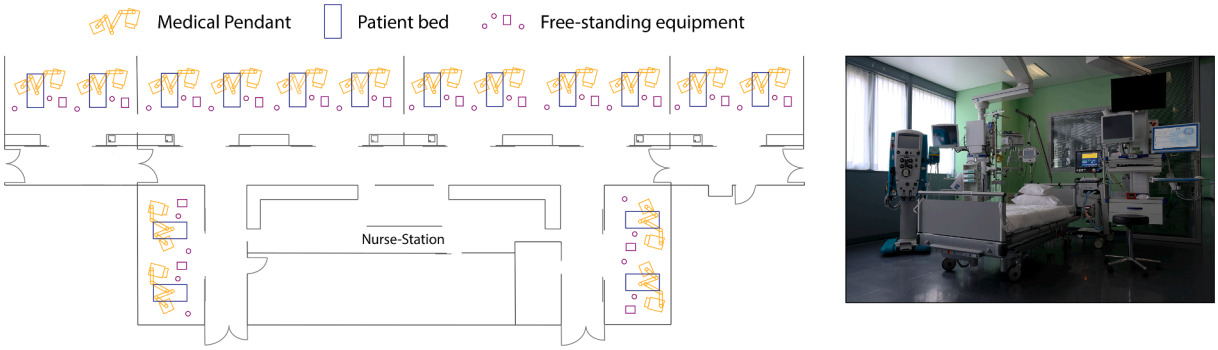

Fig. 1. Example ICU patient bed and immediate surroundings. (Left) Schematic showing a portion of the university hospital's mixed ICU, highlighting the distribution of two and four bed rooms. (Right) An example of a patient's space, including bed, medical pendant, and free-standing equipment, as outlined in the schematic.

and the number of possible responses. Due to the high proportion of patients in Swiss hospitals speaking different national languages, the patient interviews were conducted in either German or French as needed, whereas all the nurse interviews were conducted in German. The nursing experts were asked open-ended questions via semi-structured interviews (Supplementary Table 2). As more nurses were recruited to the study, ideas and themes were introduced which were subsequently probed in future interviews, to elaborate on the original questions (Korstjens and Moser, 2017). The questions for both patients and nurses were similar. For example, whereas former patients were asked to rank their preferred type of stimuli (e.g., television, books, photographs, etc.), nursing experts were asked what type of stimuli they thought a critically ill patient might enjoy experiencing.

As part of standard care, patients may enjoy television, radio, or music if they desire. Their relatives may also bring photographs and place them close to the bed. Similarly, nurses are exposed to the same types of stimuli, with no specific training that would expose them to other kinds of stimuli. Currently, in the ICU where the study took place, virtual reality is not a part of standard patient care. However, some patients or nurses in the study may have been familiar with virtual reality through personal experience. If a participant was unfamiliar with a certain stimulus, it was explained to them so they could understand it.

The patient interviews were conducted verbally by a member of the study team either via telephone or in person, in a meeting room, during a hospital follow-up visit. The patients' questions were not supplemented, and the interviews were not recorded, as the interviews were structured to be directly documented on paper. The nurse interviews were conducted in person, in a meeting room, at the hospital by two members of the study team. Whilst questions were asked verbally by both members of the study team conducting the interviews, the written version of the interviews was generated by a single team member. After each interview with the nursing experts, the interviewers discussed the preliminary results and took note of the newly generated topics, which were then brought verbally into subsequent interviews. The nurse interviews were recorded using an audio recorder to enable the study team to revisit the interviews, ensuring all points of the discussion were captured. This was done due to the semi-structured nature of the interviews, which allowed the nursing experts more opportunity to elaborate.

Data analysis

As a first step, a descriptive analysis of both groups' demographic information was performed. This included calculating the mean age and education level and the standard deviation of the two participating groups. Data from the patient interviews were also examined via quantitative analysis. Questions were left incomplete when the participant could not understand what something was or could not imagine how they would have perceived it while in the ICU – for example, virtual reality or grey noise and the like. Questions were also discarded when the participant was only able to state their most important reason for selecting their answer but could not provide a ranking across all possible answers. Descriptive analyses of the results were conducted, and boxplots were designed to visualize the data.

The data from the nursing expert interviews were analysed qualitatively via inductive content analysis and knowledge mapping. Knowledge mapping offers a method in which data can be portrayed and the collective information leveraged through visualisation including lines and arrows (Eden, 2004, Eppler, 2001). Specifically, for this study, knowledge maps allowed for the establishment of themes within the data collected from the semi-structured interviews. The knowledge maps also summarised information from the interviews and enabled it to be reduced step by step to its core categories (Mayring, 2010). The knowledge maps of the nurse interviews were then placed side by side and further reduced by combining similar topics. An individual independent of the study team subsequently checked the completeness of the core categories' content by comparing the knowledge maps with the audio recordings.

Ethical Approval

Ethical approval was obtained from the corresponding Swiss Ethics Committee (KEK-Nr. 2020-00039). In study-related documents, all participants were only referred to by codes. All study-related data was analysed and stored digitally on a password-protected server, with physical copies stored in a locked cabinet.

Findings

Former patient interviews

Demographics

A total of 22 former patients previously hospitalised in the ICU, between 32 and 73 years of age ($M = 54.00$, $SD = \pm 13.05$; $male = 15$, $female = 7$), participated in this study. A total of three interviews were removed from the final analysis due to improper completion, resulting in a final analysis sample size of 19. Of these 19 former patients, 15 were admitted to the ICU due to severe critical illness and four due to an accident. A total of eight patients were hospitalized during the COVID-19 pandemic, of which zero were during the first wave and four were during the second wave. The length of their ICU stay was between one and 31 days ($M = 14.26$, $SD = \pm 8.18$, $N = 19$). The length of time between ICU hospitalisation and follow-up was, on average, 36 weeks after their stay in the ICU. As all answers were voluntary, some questions were incomplete; therefore, the total sample size for each question was not always the same.

Table 1
Recognition preference for visual stimuli. Reasons, ordered by ranking, for preferring to see known or unknown images during visual stimulation.

Reasons for visual stimulation with known content	*M* ± *SD*	*N*
Can relate to the scene	1.14 ± 0.38	7
To feel at home	1.78 ± 0.66	9
More interesting	2.86 ± 0.38	7
Reasons for visual stimulation with new content		
It is nice to see something new (virtual travel)	1.50 ± 0.54	8
More interesting	1.88 ± 0.78	9
Don't believe it is important to know the location	2.50 ± 0.93	8

Note: Former patients ordered their reasons for preferring known or unknown visual stimulation from one to three (one being most important, three being least important), *N* = number of responses per item, *M* ± *SD* = mean ± standard deviation.

Questions relating to visual stimulation

Regarding the subjective judgement of the positive influence of visual stimulation, all 19 former patients expressed the belief that visual stimulation would have been a useful intervention for their recovery. More than half of the patients indicated a preference for viewing images without human activity (*N* = 11). Nine former patients thought it would be more enjoyable if the imagery shown was recognizable, whereas nine were interested in discovering new imagery. One participant was unable to answer the question as they could not envision what this would entail. The main reason given for the preference for recognition was having a connection to the scene shown (Table 1).

The former patients ranked their individual preference to be stimulated with different media on a rating scale from 1 (most important) to 5 (least important). The stimulation medium with the highest preference rating is "Photographs" (*M* = 2.26, *SD* = ±1.37, N = *19,* Fig. 2). Additionally, the patients ordered their preferred stimulus content on a rating scale from 1 (most important) to 7 (least important), which showed that "Nature" (*M* = 1.26, *SD* = ±0.56, *N* = *19,* Fig. 2) was the most favoured. Some patients also suggested individual preferences, such as agriculture or automotive-related images.

Questions relating to auditory stimulation

Regarding the audio environments, 17 of the 19 former patients reported that it is important to combine auditory and visual stimuli. They ordered the importance of different auditory stimulation situations from 1 (most important) to 5 (least important). The results suggest that the audio-visual combination is preferred because it is a "better distraction from ICU sound sources" (Fig. 3). The content of the background audio stimulation was ranked by the participants from 1 (most important) to 4 (least important), with a preference for nature sounds that fit the videos (*M* = 1.78, *SD* = 0.94) (Fig. 3).

Questions related to the duration of stimulation

Of the participants (N = 18), 50 % reported that 10 min would be the appropriate stimulation duration, while 22.2 % reported 15 min, 5.56 % reported 20 min, and 11.11 % reported 30 and greater than 30 min each (Supplementary Materials Table 7). Two participants suggested several short stimulations during the day, for example receiving 10 min of stimulation three separate times. The most reported reasons for the time limit of the stimulation, ordered from 1 (strongest reason) to 3 (weakest reason), were tiredness (N = 18, M = 1.28, SD = 0.46), then becoming overwhelmed (N = 13, M = 2.08, SD = 0.76), and finally, disinterest (N = 13, M = 2.54, SD = 0.78) (Supplementary Materials Table 8).

Nursing expert interviews

Demographics

A total of 12 nursing experts between the ages of 31 and 61 (*M* = 42.08, *SD* = 10.02)participated in the semi-structured interviews (male = 3, female = 9). Their mean ICU experience was 17.08 ± 11.39 years, range (4–43 years). Half of them received vocational training, and half attended a technical college, with technical schools more focused on teaching the theory and science behind the occupation, and vocational schools being more hands-on.

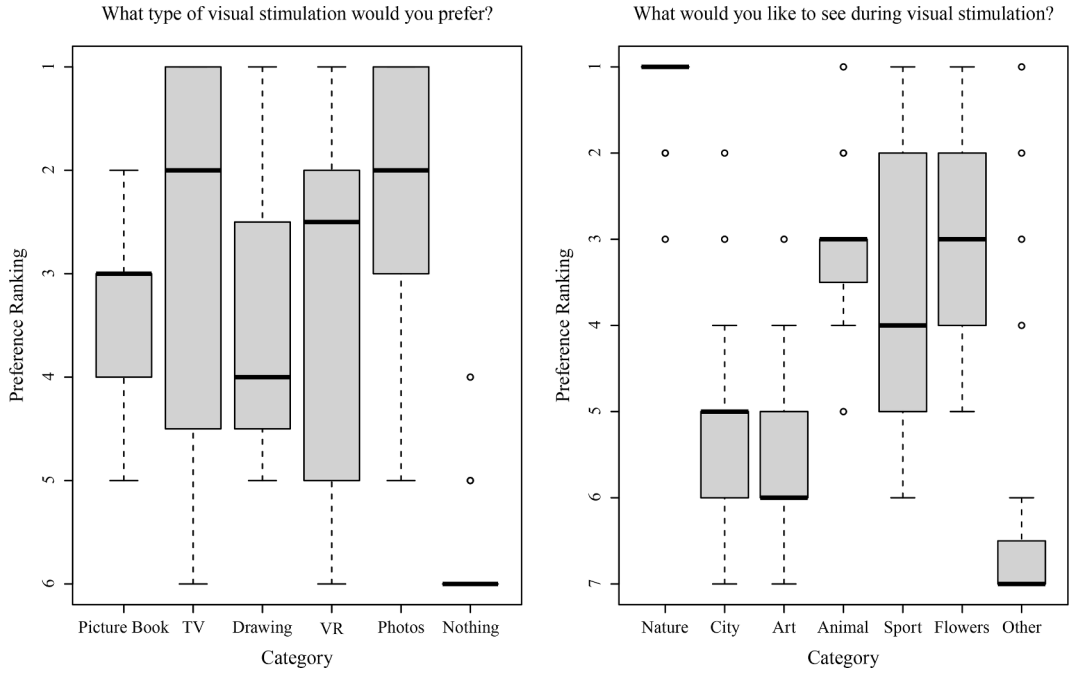

Fig. 2. Patient preferred type and content of visual stimuli. (Left) Former patient rankings of their preferred type of visual stimuli, from one being the most important to six being the least important. Abbreviations: TV = television; VR = virtual reality. (Right)Former patient rankings of their preferred content for visual stimuli, from one being the most important to seven being the least important. Thick lines represent the median, and points represent outliers. Full values in the supplementary material (supplementary Tables 3 and 4).

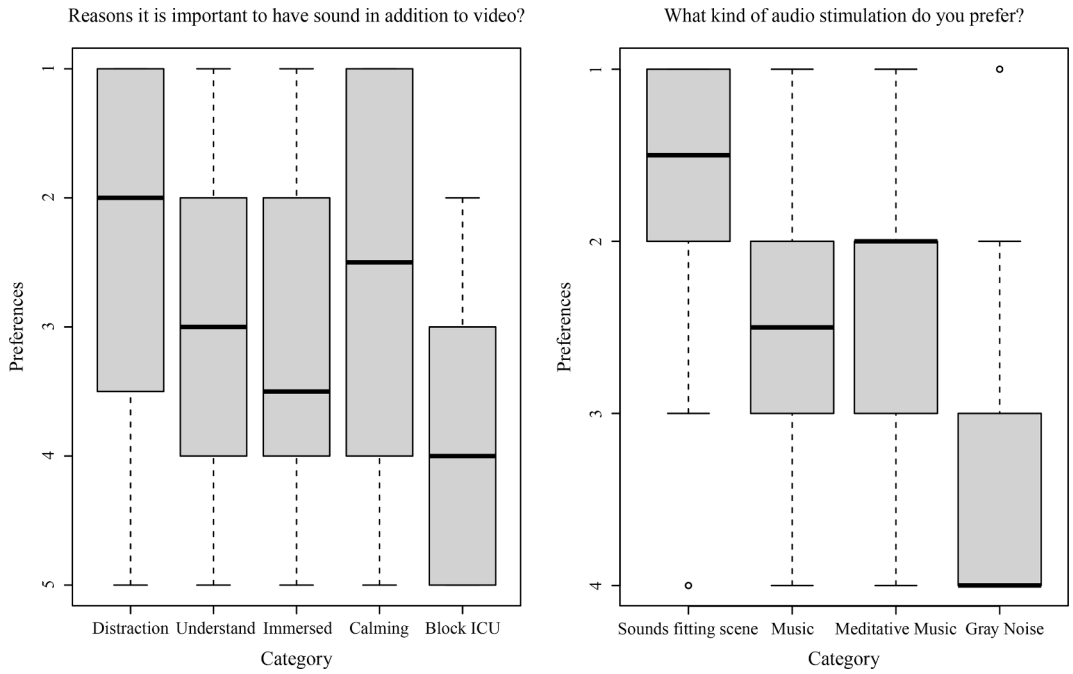

Fig. 3. Reasons for auditory stimuli and patient preferred content of auditory stimuli. (Left) Former patient rankings of their reason for indicating the need for sound combined with video, from one being the most important to five being the least important. Full x-axis labels are: distraction from the ICU noise, to better understand the video, to feel immersed in the video, to head something calming, to not be distracted by the ICU noise. (Right) Former patient rankings of the type of audio stimuli to be combined with the video, from one being the most important to four being the least important. Thick lines represent the median, and points represent outliers. Full values in the supplementary material (Supplementary Tables 5 and 6).

Visual stimulation

When asked what type of visual stimulation could be beneficial to patients, the critical care experts indicated that visual stimulation in the form of videos or photographs could benefit to critically ill patients. Another form of visual stimulation presented during the interview was virtual reality (VR). The nurses reported three essential themes concerning the content of visual stimuli. One theme involves the atmosphere of the content displayed, such as the colour, which, according to the nursing experts, could influence how positively or negatively the patients interpret what is shown; for example, the nursing experts believed yellow to be a positive colour due to its association with the sun. With the nurses expressing sentiments such as,

> *"[…] something friendly that has a calming effect."* (EN1)
> *"[…] light colours like green, nothing aggressive like red."* (EN2)
> *"Yes, neutral colours are for me all pastel colours actually, or generally base colours, blue, green, red, yellow, are rather a bit neutral. I know pink has a relatively calming effect…"* (EN3)

Furthermore, peaceful nature content, such as lakes or meadows, was also reported to positively influence the images' atmosphere. One nurse provided the example of a bird, stating,

> *"[…] the bird might be that which for a lot of people symbolizes freedom, which for [patients] might be an important theme."* (EN4)

The same nurse also elaborated further on the types of animals they believe would be well suited for patients.

> *"[…] or a deer. It's such an innocent object where we say, "awe cute, a deer". I think it has to be something like that. A dog is again so [sic], there are also people who don't like dogs…"* (EN4)

On the other hand, scenes including cliffs or storms which may cause concerns for one's safety and were not recommended. When considering the nuances between appropriate nature scenes, one nurse explained,

> *"A forest is again difficult, because forests are dark. Rather an individual tree or two trees in a field [would be better]."* (EN2)

Table 2
Content for visual stimulation. Main topics concerning visual content as expressed by the nursing experts.

Atmosphere	Recognition	To avoid
Colour	*Family members* (including children)	*Scary scenarios*
- Dark colours may be negative - Pastel colours may be positive - Yellow may be positive (mimics sun) - Red may seem aggressive - Pink can be tricky as it may be positive, but it can also be provocative for some patients as it can be a gender-specific colour		- Scary animals (e.g., spiders) - Forces of nature (e.g., volcanoes) - Extreme sports - Oneself in hospital
	Pets	*Death-related images*
		- Blood - Cemeteries
Places	*Places the patient knows* (e.g., their home region)	*Others*
- Mountains - Lakes - Heaven - Cities		- Hospital (except for orientation) - Stressful scenarios - Interactions with the patient

Another theme focuses on familiar content, such as family members, which might help prevent delirium. However, the experts also indicated the possibility that images of family members may cause the patient emotional pain. The last theme concerns certain visual stimuli which should not be presented as they could lead to stress, such as scenes related to death, or some animals, which could induce fear (Table 2). One of the nurses highlights the nuances between fear and delight.

> *"Bears are very big and strong and muscular and rather prone to attack. Baby bears are cute. Small animals are cute. These are cute. They make you happy and you automatically start to smile."* (EN2)

Concerning the duration of the visual stimulation, the nursing experts considered 15 min to be a satisfactory length. They argued that if the stimulation is longer, it may become overwhelming for the patient, lead to fatigue, or decrease comprehension. One expert added,

> *"It is essential that the stimulation is integrated into the daily routine in a timely and regular manner, so that the patient recognises the stimulation offer again and the individual duration can be determined."* (EN5)

The healthier the patient becomes, the longer the stimulation may be without these negative effects. However, the image should not be presented for too short a period, because the critically ill patient may need time to immerse themselves into the video. This may particularly be the case when the patient is under sedation. Regarding static images specifically, not videos, the nurses recommended not to exceed 20 min to avoid monotony and fatigue.

Auditory stimulation

In general, the nursing experts expressed their belief that auditory stimulation should not disturb the patient. As one nurse explained,

> *"Patients already have a lot of noises. They hear everything, which is why it should rather be something calming."* (EN2)

Shrill or complex auditory stimuli were not recommended. Moreover, the audio should remain unobtrusive and in the background.

> *"[…] something meditative similar to [during] yoga which is just very soothing and in the background. I wouldn't have it too present. More in the background, a quiet melody, and not too loud."* (EN1)

Several different sorts of auditory stimulation can be utilised. One approach is real-life audio, such as radio, laughing children, or the voices of family members. Another possibility is calm audio such as nature sounds, pink noise, or instruments which was reported to have a positive influence. One expert mentioned that,

> *"Many people relate to sounds in nature, but music is very much influenced by individual preferences."* (EN5)

Moreover, auditory stimulation which fits the visual stimulation could support visual immersion; this combination is, therefore, recommended by the nursing experts. In their opinion, the duration of audio stimulation on its own should not exceed one hour.

Discussion

To better understand what former patients desire in terms of sensory input, a mixed-method design was used to interview the patients and nurses. The goal of the study was to gain insight into how the ongoing problems of sensory overload and sensory deprivation in ICUs can be addressed (Holm and Dreyer, 2017; Tronstad et al., 2021). The former patients who participated in this study indicated a clear preference for receiving visual and auditory stimuli versus not receiving any stimuli at all. This is in line with the opinion of nursing experts who also believed providing visual and auditory stimuli to critically ill patients are important for their recovery. To our knowledge, this is one of the first studies, which assessed the preferences of former patients on the ICU as well as the expertise of nursing experts on the topic of visual and auditory stimulation.

In line with what the nursing experts expected, former patients reported a desire to receive visual stimuli in the form of photographs or television. Patients may prefer photographs as they can provide a connection to loved ones and their life outside the hospital. The positive impact of relatives on patient recovery has become more evident in recent years (Kirkjebø et al., 2019; Yousefi et al., 2015) and investigating if this beneficial impact can be transferred via photographs could be of interest for future work. However, the nursing experts also suggested that presenting images of relatives may, conversely, sadden patients; therefore, care must be taken in this regard. Working together with the family, and if possible, directly with the patient to select appropriate content could be an ideal solution to this problem.

The nursing experts and the former patients offered differing opinions on desirable content for visual stimulation. Both agreed that nature scenes, including flowers and animals, would be enjoyable. Literature has shown that nature has a stress-reducing effect on individuals and that this effect can be replicated artificially (Anderson et al., 2017; Annerstedt et al., 2013; de Kort et al., 2006). Certain types of visual stimuli, such as virtual reality, could be utilised to enable exposure to both nature and changes in lighting, thus helping patients to relax and re-establishing their circadian rhythms. However, while the patients and nurses both agreed that stimulation content involving animals could be enjoyable, the nursing experts also noted that fear-inducing animals, such as spiders, should be avoided. Opinions on animals such as dogs and bears were less aligned. This highlights the point that it is difficult to create clear-cut guidelines which apply to all patients, and that any type of stimuli provided will be dependent on individual desires. For example, patients who are more alert and engaged with their surroundings may desire more engaging content. The extent to which the COVID-19 pandemic has influenced patients' visual preferences cannot be assessed based on our data. However, as our hospital resources were not overwhelmed during the pandemic, the daily routine of patients was not drastically changed in comparison to pre-pandemic times.

One way to promote patient engagement with visual content is to combine it with audio content. This was the clear preference expressed by the patients and supported by the experts because it does not disturb the patient. The former patients made it clear that, if presented with visual stimuli, they would prefer that the sounds match the scene being shown. They asserted that this combination would provide the most distraction from ambient ICU noises. This likely ties into the notion of immersion: by experiencing both auditory and visual content, the patient can become more easily immersed in the stimuli they are exposed to, thereby lessening the prominence of the ICU environment (Jennett et al., 2008).

In terms of length, the nursing experts stated that, for immersion to occur, the patient needs to be given enough time to become fully aware of and engaged with the stimuli. They suggested that auditory stimulation could last up to one hour, but visual stimulation should not last longer than 10–15 min. Regarding the length of exposure to stimulation, future work should investigate whether visual stimuli are more tiring than auditory stimuli, as suggested by the responses of the former patients as well as the nursing experts.

Limitations

As the study was conducted as part of an intervention development for a single-centre study, its generalisability may be limited. Therefore, it is not possible to know if the results found here are entirely applicable to other hospitals or other countries and could be addressed in future research. However, most hospitals should have the capacity to implement the types of stimulation discussed here. Another limitation of this study is that these questions were asked during a standard patient follow-up visit or call. Patient follow-up visits often occur approximately six months post-discharge. This is the case as often patients do not go directly home after being discharged, for example due to inpatient physical rehabilitation, or experience emotional challenges making it difficult to accept their ICU hospitalisation. In the case of this study, follow-ups were done on average 9-months post-ICU discharge in part due to the COVID-19 pandemic, during which these follow-up visits were postponed. Despite time having passed between their hospitalisation and the interview, and even if detailed memories were absent, patients were usually able to recall their feelings whilst in the ICU. Additionally, during the follow-up visit, patients are taken to see the ICU and review their diagnosis and treatment with healthcare professionals who involved in their care, which helped the patients understand their experiences and refresh their memories. In this way, we do not expect

that the delay between discharge and follow-up affected the results. Finally, as we did not record the follow-up visits, and thereby, the interviews of the patients, this may have influence on the richness of the data.

The study team acknowledges that interviewing individuals once they have been discharged from the ICU is a limitation; future work might focus on interviewing patients whilst still in the ICU, but that will present its own challenges. Many former patients had not yet fully recovered, meaning that sometimes the follow-ups were conducted via telephone if the patient was not healthy enough to travel back to the hospital. Though, as both the in-person and telephone interviews were conducted verbally, this is not expected to have impacted the results. However, based on clinical experience, it was noted that due to the health of participants, answering many questions could be very tiring, particularly as the interviews were completed as part of a lengthier follow-up visit. Due to this, it was often challenging to pose many open questions or collect completed answers. To ease this burden, structured interviews were conducted with the former patients, versus the semi-structured interviews with the nursing experts.

Regarding the small sample size, research has found that a sample size of nine is sufficient to develop a comprehensive understanding of the ideas, but not to understand all dimensions of the topic (Hennink et al., 2017). To achieve an understanding of both the general concept and all nuances, a minimum sample size of 16 is required. This was not achieved for the nurse population. However, as Hennink et al. (2017) also explain, saturation is also dependent on additional factors such as the study purpose, and nine interviews may be sufficient when concentrating on broader themes rather than developing complex theories.

Finally, it is important to remember mind that every-one is different, and while these findings provide a basis for stimulation in the ICU, stimuli remain a personal choice. Despite these limitations, this study provides valuable insight into how caretakers can contribute to the recovery of critically ill ICU patients by providing meaningful stimulation to these individuals.

Conclusion

This study begins to address the lack of information regarding sensory stimulation in ICUs, which could be useful in tackling sensory overload and sensory deprivation in this environment. Overall, participants indicated that they would enjoy receiving visual stimuli such as photographs depicting nature scenes, together with audio where appropriate, for approximately 10 min a day. This is largely aligned with the opinion of clinical care experts.

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CRediT authorship contribution statement

Aileen C. Naef: Conceptualization, Methodology, Data curation, Investigation, Visualization, Writing – original draft, Writing – review & editing. **Katja Erne:** Data curation, Investigation, Writing – original draft. **Matthias Thomas:** Conceptualization, Methodology, Writing – original draft. **Tobias Nef:** Conceptualization, Resources, Writing – review & editing. **Marie-Madlen Jeitziner:** Conceptualization, Methodology, Data curation, Resources, Project administration, Investigation, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.iccn.2022.103306.

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