Non-pharmacological Interventions for People with Dementia: Design Recommendations from an Ergonomics Perspective

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Abstract. Non-pharmacological interventions have been applied to manage Behavioural and Psychological Symptoms of Dementia (BPSD). However, these interventions have not been assessed from an ergonomics perspective. Ergonomics has investigated the age-related capability changes in terms of sensory, cognition and movement aspects. This study aims to review the existing non-pharmacological interventions for BPSD targeting nursing home residents and generate design recommendations based on the domain of ergonomics in ageing. The electronic databases MEDLINE, EMBASE, PsycINFO were searched for studies which applied non-pharmacological interventions for treating BPSD in nursing home residents. A total of 67 studies met the inclusion criteria; from which 16 types of interventions were identified. Within these intervention types, the main capabilities required from the interventions for People with Dementia (PwD) were identified. The interventions were then categorized into sensory-, cognition-, and movement-oriented according to the main capabilities. Design recommendations were then generated for the interventions with knowledge from the domain of ergonomics in ageing.

Keywords: Ageing population · Sensory capabilities · Cognition
Movement · Behavioural and Psychological Symptoms of Dementia
Intervention design

1 Introduction

Antipsychotic medication is frequently prescribed to relieve Behavioural and Psychological Symptoms of Dementia (BPSD). However, they have low efficacy with serious side effects such as increased mortality and stroke occurrence [1]. Consequently, non-pharmacological interventions have been developed with the attempt to reduce the use of antipsychotic medicine in the management of BPSD. Several systematic reviews have investigated the effectiveness of these interventions and found the level of evidence for all these interventions is generally low [2–7].

This study proposes that improving intervention designs is one approach to increase the level of evidence, and these intervention designs could be potentially improved by applying knowledge from the domain of ergonomics in ageing. This domain of ergonomics has investigated the capability changes of healthy individuals as they age

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[8], and the majority of People with Dementia (PwD) belong to the elderly age group. For instance, in the United States 96% of people with Alzheimer's Dementia are above the age of 65 [9]. This means that changes in capabilities because of ageing is also applicable for the majority of PwD.

The age-related capabilities investigated so far have been classified into sensory, cognition and movement aspects [10]. Some capabilities were found to be reduced (e.g. vision, auditory, working memory) [11–14] while some were reported to be relatively intact in the elderly (e.g. semantic memory) [15]. These findings have been implemented into the adaptation of working place, products and services for the elderly with reported improvement in both their performance and well-being [12]. The domain of ergonomics in ageing could be extended to designing non-pharmacological interventions for PwD. Specifically, the PwD should have the capabilities to participate for the results of the interventions to be reliable.

Previous reviews have not assessed these interventions based on the capabilities of PwD. Besides, these reviews have not distinguished between the interventions targeting PwD from those targeting caregivers [2–7]. As only the capabilities of the PwD are of interest, this study focuses on interventions targeting PwD. Therefore, our study aims to first review literatures on interventions for BPSD targeting nursing home residents and age-related capability changes reported in ergonomics, then generate design recommendations for these interventions by aligning with the capabilities to improve the intervention designs.

2 Method

This study was conducted in several steps. Firstly, studies on interventions for BPSD targeting nursing home residents from 1998 to 2018 were systematically reviewed. Only studies written in English and published in peer-reviewed journals were included. The literature search was implemented in three electronic databases: MEDLINE, PsycINFO and EMBASE. The intervention types were then identified from these studies. After that, the capabilities that PwD should have to be able to participate in each intervention type were identified. The interventions were then categorized into sensory-, cognition-, and movement-oriented according to the main capability they required from the PwD. The ergonomics literature on age-related capability changes was reviewed. The findings in age-related capability changes was applied to generate design recommendations for the interventions. The steps are summarized in Fig. 1.

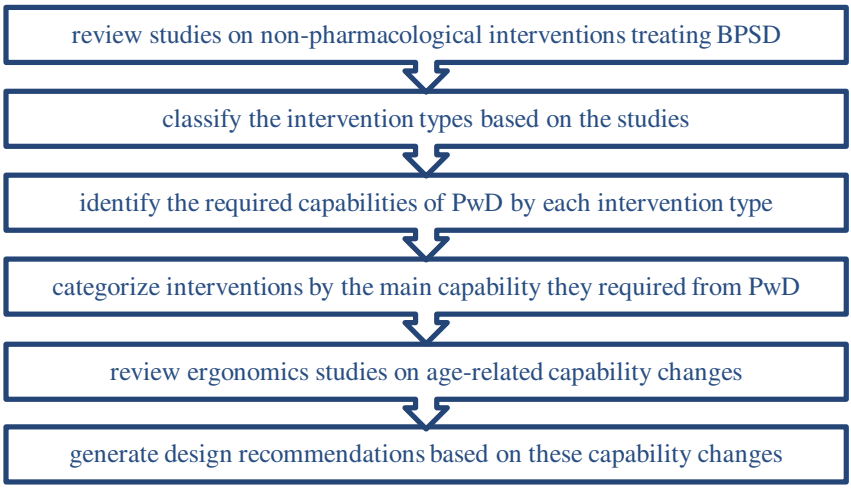

Fig. 1. A flow diagram of this study

3 Results

After the systematic review, 67 studies met the inclusion criteria. We found 16 intervention types in total. An overview of these studies is shown in Fig. 2. The number of studies conducted on one intervention type is indicated between brackets. The references to these studies are available upon request.

Sensory-oriented interventions have been investigated by more studies than cognition- and movement-oriented interventions. Specifically, 9 intervention types require the PwD to have certain level of sensory capability, 5 intervention types require the PwD to have certain level of cognitive capability and 2 intervention types require the PwD to have certain level of movement capability. The sensory-oriented interventions were investigated by 47 studies, while the cognition- and movement- oriented interventions were examined by 11 and 9 studies respectively. Within sensory-oriented interventions, music therapy has been evaluated by 21 studies, which is the most-investigated intervention. Several interventions have been evaluated by one study only.

A few studies have compared the effectiveness of two intervention types (e.g. music therapy vs simulated presence therapy [16]); however, no study has compared two designs of the same intervention type (e.g. music therapy with generic music or preferred music by PwD).

The age-related capability changes reported in the sensory aspect are auditory, olfactory, visual and somatosensory capabilities. The capability changes described in the cognition aspect are attention, memory, and executive control. The capability changes stated in the movement aspect are balance, muscular strength, movement speed, and locomotion. The changes of these capabilities with age will be described in the Discussion Section.

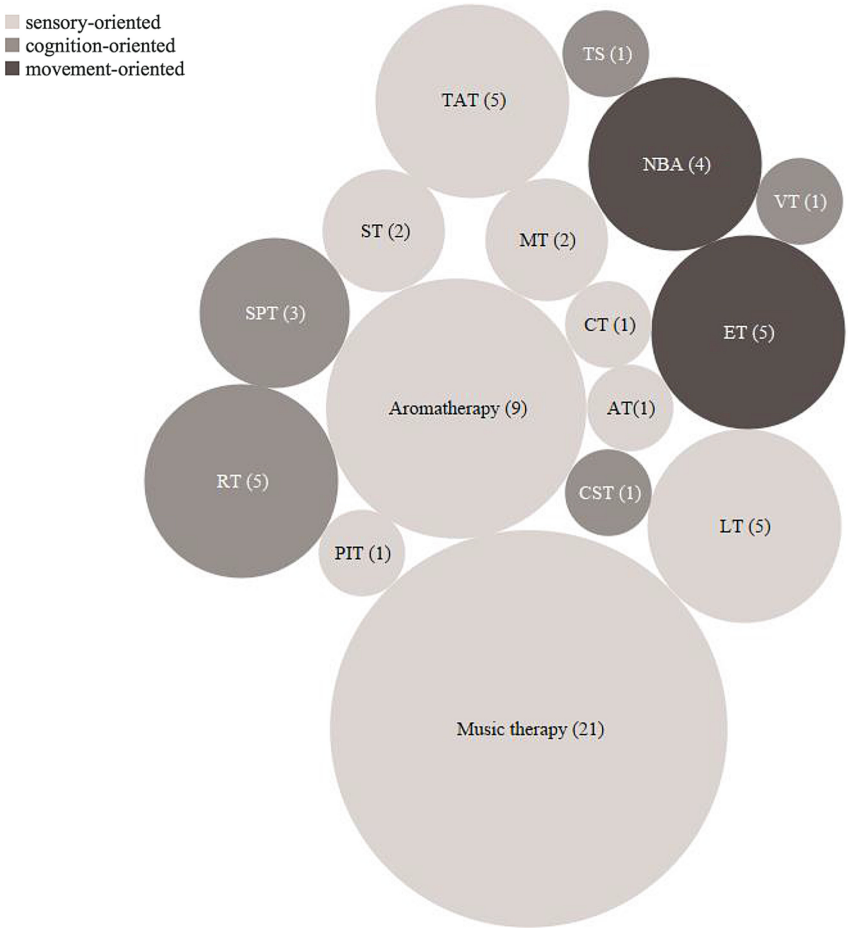

Fig. 2. Overview of non-pharmacological interventions for BPSD after categorization. AT = Animal Therapy; CST = Cognitive Stimulation Therapy; CT = Clowning Therapy; ET = Exercise Therapy; LT = Light Therapy; MT = Massage Therapy; NBA = Nature-Based Activities; PIT = Positive Image Therapy; RT = Reminiscence Therapy; SPT = Simulated Presence Therapy; ST = Snoezelen Therapy; TAT = Technology-Assisted Therapy; TS = Time Slips; VT = Validation Therapy.

4 Discussion

The outcome of this study is to generate design recommendations based on findings from ergonomics in ageing to potentially improve the interventions for BPSD targeting nursing home residents. In general, sensory-oriented interventions have larger variety and have been relatively more evaluated than cognition- and movement- oriented interventions. The results also revealed that the effect of intervention designs on effectiveness needs to be explored. The design recommendations for intervention designs are discussed below in terms of the intervention categories.

4.1 Sensory-Oriented Intervention

A sensory-oriented intervention could be enhanced by considering the change of auditory, olfactory, visual and somatosensory capabilities due to ageing. The recommendations are given for a few interventions as examples, which can be applied to other interventions involving these capabilities.

Music therapy mainly involves the auditory capability. The two age-related auditory deteriorations are in auditory acuity and localization. The auditory acuity is the ability to detect sound, which deteriorates the most for high-frequency sounds [14]. The auditory localization is the ability to localize sound, which also declines the most for high-frequency sounds [17], and the elderly are especially prone to front/back localization errors [18]. Therefore, the music therapy could be improved by locating the sound source close to the PwD to compensate for the reduced auditory acuity. The sound source should be placed at the sides of PwD to avoid issues with localizing sound sources. In addition, music with low frequency should be selected.

In terms of *aromatherapy*, the olfactory system is the most involved. Olfactory impairment is common among the elderly, and the impairment depends on the type of aromatic components, which varies from individual to individual [12]. Four studies applied the aromatic components dermally or of high concentration and showed the BPSD were significantly alleviated after the intervention [19–22]. The other five studies delivered the aromatic components by spray in low concentration and found there was no significant improvement in BPSD [23–27]. Only three types of aromatic components have been evaluated so far: lavender, thyme and Melissa officinalis [19–27]. Therefore, the *aromatherapy* could be enhanced by applying the aromatic components dermally or of a high concentration and experimenting with a few more aromatic components. Due to the variation in olfactory impairment among PwD, a few aromatic components could be compared to identify the most effective one for each PwD.

For *light therapy*, the main sense involved is vision. Exposure to bright light could restore the circadian rhythm, and this rhythm is commonly disturbed in PwD [28]. Artificial light is normally used in the interventions with a higher intensity than the standard light [29]. Visual deterioration of the elderly means that more illumination is required for them to see adequately [12]. Therefore, besides circadian rhythm restoration, another possible benefit of this therapy would be that it allows PwD to see their surroundings more clearly. The capability of elderly adults to adapt to darker conditions is reduced [11], and their susceptibility to glare is higher than that of young adults [30]. Thus, the *light therapy* could be improved by reducing the brightness in the room gradually at the end of the intervention to allow PwD time to adapt to the standard light condition. In addition, the emitted light should be diffused to create ambient light and reflecting surfaces (e.g. mirrors) should be avoided to reduce glare in the therapeutic room.

A *Snoezelen therapy*, also called multisensory therapy, gently stimulates the senses of sight, hearing, smell, and touch of the PwD [31]. In terms of sight, the PwD are exposed to lighting conditions with a wider wavelength spectrum than in *light therapy*. The variety of colors used in the therapy aims to engage the visual system of PwD [32]. It has been found that the elderly have more difficulty discriminating and perceiving short wavelength light [33]. Therefore, it is recommended that objects with short-

wavelength lighting should be separated from backgrounds with similar lighting conditions even though their colours are different (e.g. blue and violet). The elderly have been found to have difficulty in sensing the weight of objects, which results in more variability in maintaining constant force when grasping an object [13]. This capability change could increase the number of dropping incidents which disturb the therapy. Thus, the objects which are easy-to-hold and drop-proof are advised to be used in the therapy. The recommendations of *music therapy* and *aromatherapy* could also be applied, as *Snoezelen Therapy* also employs the auditory and olfactory systems.

4.2 Cognition-Oriented Intervention

A cognition-oriented intervention could be improved by incorporating the changes in attention, memory, and executive control during ageing. The recommendations given in this section are applicable to all cognition-oriented interventions.

In terms of attention, the elderly have reduced capability to inhibit irrelevant information [34], thus, it is of importance to remove distractors during the therapy. A dedicated room is advised to help PwD to concentrate more during the therapy. Some prompts could be designed to redraw the attention of the PwD back to the intervention for the interventions not conducted by therapists. For instance, in *simulated presence therapy*, the PwD is mainly guided by the audio or video recording instead of the therapist. The PwD could get distracted during the intervention which might not be noticed immediately, thus affecting the outcome of the intervention. Even if a therapist notices and reminds the PwD, this reminder would disturb the flow of the therapy. Therefore, embedding some prompts in the audio or video recording would help PwD to stay focused on the therapy without disturbances.

There is a decline in the working memory [13], episodic memory [35] and prospective memory [36] in the elderly except the semantic memory [15]. The *reminiscence therapy* and *simulated presence therapy* have already utilized this capability change and structured conversations with PwD based on their semantic memories. For example, old photos, nostalgic music, and voices of family members were applied to stimulate the semantic memory in these therapies. Due to the decline in the working memory [13], the elderly might forget the beginning of a sentence by the time the sentence is finished for a long sentence. Similarly, as the ability of language comprehension depends on the interaction of working memory and semantic memory, it is also difficult for the elderly to comprehend a sentence in which many words and clauses bisect the subject and verb [13]. Therefore, the instructions and questions to the PwD should be simplified and shortened during the interventions. Due to the decline in the episodic memory [35], the PwD could forget the topic of their talk during the conversation, which could trigger negative emotions in them. Hence, it is recommended to constantly remind PwD about what they have been talking about without interrupting the conversation. A memory aid could be developed based on the technology of real-time transcription, which could remind the PwD about what has been said in the conversation in a written form. Due to the reduction in prospective memory [36], it is advisable to minimize conversations related to future planning during interventions.

Lastly, decline in executive control has been found in the elderly [37]. Executive control encompasses a range of cognitive activities such as planning, sequencing and multitasking. Thus, it is recommended that the activities in these interventions are designed to involve short-term feedbacks, less steps, and one cognitive task at a time.

4.3 Movement-Oriented Intervention

A movement-oriented intervention could be enhanced by considering balance, muscular strength, movement speed and locomotion in the elderly. Movement-oriented interventions are more likely to cause physical injuries than sensory- and cognition-oriented interventions. As a result, it is important to consider these capability changes to avoid injuries. The recommendations given in this section are applicable to all movement-oriented interventions.

In terms of balance, postural sway increases with age [38]. Falls due to postural sway is a serious problem for the elderly [39]. This age-related postural sway is greater when the person is standing on a more compliant flooring [40]. Consequently, the interventions are recommended to be carried out on a hard flooring to minimize the risk of fall. Protective clothing should be worn by the PwD in the meantime in case any fall incidents. The muscular strength drops with age [41]. It is essential to be aware of the lowered strength and endurance limits of PwD to design suitable and safe postures and movements for them. Water therapy, such as swimming pool exercises, could be incorporated for PwD whose muscular strength is inadequate for lifting their body weights. In addition, the elderly are slower in movement than young adults [42], hence, the therapists should demonstrate the postures and movements at a rhythm slow enough for PwD. Regarding locomotion, the elderly have shorter steps and increase in the time that both feet are on the ground [43]. This gait change is the strategy of the elderly to maintain balance. This strategy should be incorporated to the design of postures and movements in the interventions.

4.4 Selection of Intervention

Selecting the suitable intervention for each PwD is also an essential component of intervention design. According to ergonomics in ageing, the heterogeneity of various capabilities is larger in the elderly in comparison with that in young adults [10]. In terms of managing BPSD in a nursing home, it is unlikely that one intervention could be suitable for all residents; e.g. music therapy might not be suitable for PwD with auditory impairments. Therefore, it is advised to create a capability profile for each PwD, and the suitable intervention for a PwD could be identified by matching the capabilities required in the intervention with the remaining capabilities of the PwD. The changes in capabilities over time for each PwD could also be tracked with the profile so that other suitable interventions could be identified as the disease progresses.

5 Conclusion

This study provides an overview of important considerations for interventions treating BPSD from an ergonomics perspective. The interventions for BPSD from 1998 to 2018 were reviewed and categorized into sensory-, cognition- and movement-oriented. Most of capabilities in these three aspects have been found to decline with age apart from semantic memory. As the majority of PwD belong to the elderly age group, the interventions for BPSD could potentially be improved by aligning with the capabilities of the elderly in view of these age-related changes. A summary of design recommendations based on the capabilities involved in the interventions is shown in Table 1. This study establishes a start point of utilizing ergonomics findings in ageing to design non-pharmacological interventions for BPSD targeting nursing home residents. In the future, the design recommendations stated in this paper should be validated in clinical trials.

Table 1. Summary of recommendations for non-pharmacological interventions treating BPSD

Intervention categories	Involved capabilities	Recommendations
Sensory-oriented	Auditory	Locate sound sources closer and by the sides of PwD; use low-frequency sounds
	Olfactory	Apply aromatic components dermally or of high concentration; experiment with various aromatic components and compare their effects
	Visual	Reduce brightness gradually at the end of intervention; diffuse emitted light; avoid reflecting surfaces; apply short-wavelength light carefully
	Somatosensory	Use objects to be easy-to-hold and drop-proof
Cognition-oriented	Attention	Conduct interventions in a dedicated room; embed prompts in the interventions
	Memory	Stimulate semantic memory; use short and simple sentences; use memory aid for PwD; avoid questions about future
	Executive control	Minimize activities involving planning, sequencing and multitasking
Movement-oriented	Balance	Carry out movement on hard flooring with protective clothing
	Muscular strength	Use movement with lower intensity
	Movement speed	Use movement with slower rhythm
	Locomotion	Use movement mimicking the locomotion of the elderly

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