

Preliminary Study on Design of Elderly Seats Using Evaluation Grid Method: Assistive Cushions for Sitting and Standing Support [†]

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Abstract

We explored the elderly's preferences and perceptions of standing assistive cushions. Using the evaluation grid method (EGM) and Miryoku Engineering, we interviewed 10 elderly users to identify key attractiveness factors, revealing a preference for cushions with handles and stable support for enhanced safety and usability.

Keywords: standing cushion; application of evaluation grid method; elderly seating; standing and sitting

1. Introduction

With the rapid aging of the global population, improving the design of assistive devices for the elderly has become urgent. According to the United Nations, by 2050, one in six people globally will be over the age of 65, and the population aged 80 years old and above will triple, reaching 426 million [1]. Due to mobility and independence declines with age, there is a growing demand for supportive and functional chairs, particularly for assistive seat cushions that aid in standing up. Therefore, regarding the psychological impact of choosing assistive seat cushions, we interviewed elderly users to explore their subjective perceptions, preferences, and influencing factors related to assistive seat cushions. We conducted a systematic analysis and summarization of users' preferences and influencing factors. By examining user preferences for assistive seat cushion selection with the evaluation grid method (EGM), we determined the psychological structure of user attraction to assistive seat cushion features, providing a basis for the design of assistive devices. We proposed design solutions tailored to the needs of elderly users, thereby enhancing the market competitiveness of such assistive products.

2. Literature Review

2.1. Needs and Challenges of Assistive Chairs for Elderly

Standing up and sitting down are daily activities of the elderly. As people age, their muscle endurance decreases, particularly in the lower limbs, making it increasingly difficult to rise independently. According to a study by Van Lummel et al., the ability to stand up is an essential indicator of the daily functional capacity of older adults. Assistive chairs significantly reduce the risks associated with standing up and sitting down, especially for individuals with reduced lower limb function or mobility issues [2]. Zhong et al. emphasized that assistive devices enhance the independence of older adults and alleviate the burden on caregivers, improving the quality of daily life for seniors in both household and community environments [3]. In



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terms of assistive chair design, older adults prefer designs with stable backrests and appropriate seat heights to provide adequate support during standing and sitting [4]. Assistive chairs must address the need for standing assistance, body support, and user comfort.

2.2. Design and Application of Assistive Seat Cushions

In the design of seating for older adults, the assistive seat cushion is an essential feature as it mitigates the difficulty of sitting and standing, thereby enhancing independence and safety. As aging progresses, standing up independently becomes increasingly difficult. To address this issue, assistive seat cushions incorporate mechanical aids, such as pneumatic rods or springs, to provide additional thrust for standing up while lowering slowly when sitting to reduce pressure on the knees and hips.

Zhong et al. stated that assistive devices must comply with universal design principles to ensure that older adults live independently in home or community settings. Therefore, the design of assistive seat cushions must be created in various application scenarios, including chairs, wheelchairs, and beds, emphasizing adjustability and portability to meet the needs of older adults with different body conditions and weights [3]. Tsai noted that the appropriate configuration of seat height and armrest height significantly affects the stability of standing up for older adults. As a result, assistive seat cushion design needs to prioritize these parameters to minimize the risk of falls during the standing process [5].

The design of assistive seat cushions for older adults must be created for safe standing assistance while ensuring lightweight, stability, and multi-purpose functionality. These features are essential to effectively enhance the autonomy and comfort of older adults in daily life.

2.3. Types of Assistive Devices

In recent healthcare and caregiving, assistive devices are essential tools used to improve the quality of life for the elderly and individuals with functional limitations. With an aging population and continuous technological advancements, the variety of types and functions of assistive devices has significantly increased. Assistive devices are categorized based on functionality, usage scenarios, and user needs, providing a critical theoretical foundation for their design and application.

Functional classification is the most common approach in assistive device research and design. In Taiwan, assistive devices are classified into 12 categories: personal medical aids, skill training, orthotics and prosthetics, personal care and protection, personal mobility, home living, furniture and modifications for home and other places, communication and information, handling goods and devices, tools, machinery and environmental improvements, leisure, and comprehensive categories (Ministry of Health and Welfare, Taiwan) [6].

We focused on personal mobility aids, specifically assistive seat cushions, to design an assistive device to assist the transition from a seated to standing position for individuals with limited mobility, particularly the elderly or those with weakened muscle strength. The function of the cushion helps users stand up by reducing joint pressure and enhancing user autonomy. Based on market-available seat cushions, we categorized them into electric and non-electric, and ergonomic and non-ergonomic designs, to explore their application and effectiveness in mobility assistance.

2.4. Kansei Engineering

Kansei Engineering, introduced by Japanese scholar Masato Ujigawa in 1991, aims to “create attractive products and spaces through scientific techniques and knowledge” [7]. The “charm” refers to a psychological attraction that influences and appeals to consumers, endowing products with desirable attributes such as aesthetic style, texture, and taste, thereby capturing consumer attention [8]. The primary research methodology in Kansei Engineering is EGM proposed by Junichiro Sanui, which involves in-depth interviews. Through a comparative

analysis of Products A and B, EGM is used to identify respondents' conceptual perceptions and categorize conditions [9]. While Kansei Engineering is commonly applied in analyzing product attractiveness, its application to assistive devices remains limited. To address this gap, we employed Kansei Engineering to analyze different assistive seat cushions. By using Kansei Engineering, we identified the characteristics of assistive seat cushions that appeal to the elderly, such as comfort, ease of use, and aesthetic preferences. The results provide theoretical and practical information to enhance the design and appeal of assistive seat cushions.

3. Research Methodology

To investigate the factors influencing user psychology and behavior in the selection of assistive seat cushions, EGM was employed. The research was conducted in four stages outlined in the flowchart shown in Figure 1.

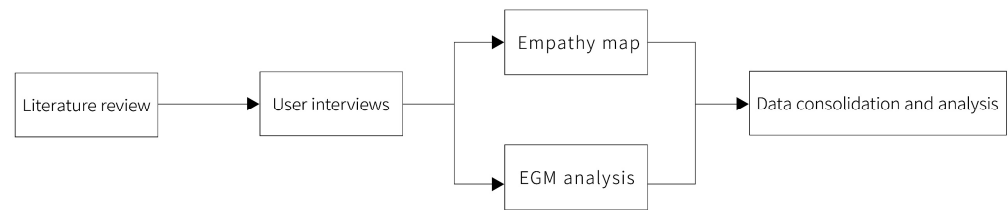


Figure 1. Research flowchart.

3.1. Image Collection and Sample Selection

We collected commonly seen images of assistive seat cushions from online shopping platforms (e.g., Amazon). To better reflect real-life usage scenarios, the collected images included chairs used with cushions for different uses. According to the study's constraints, all images were standardized by presenting the cushions at a 45-degree angle, removing backgrounds, and desaturating the colors to create uniform research cards. To ensure the representativeness and diversity of the images, a preliminary selection process was conducted. One expert with 10 years of industrial design experience and three graduate students from an industrial design program eliminated similar assistive cushions to maintain the uniqueness of each sample and evaluated the images. The final selection comprised 28 images, as shown in Figure 2.

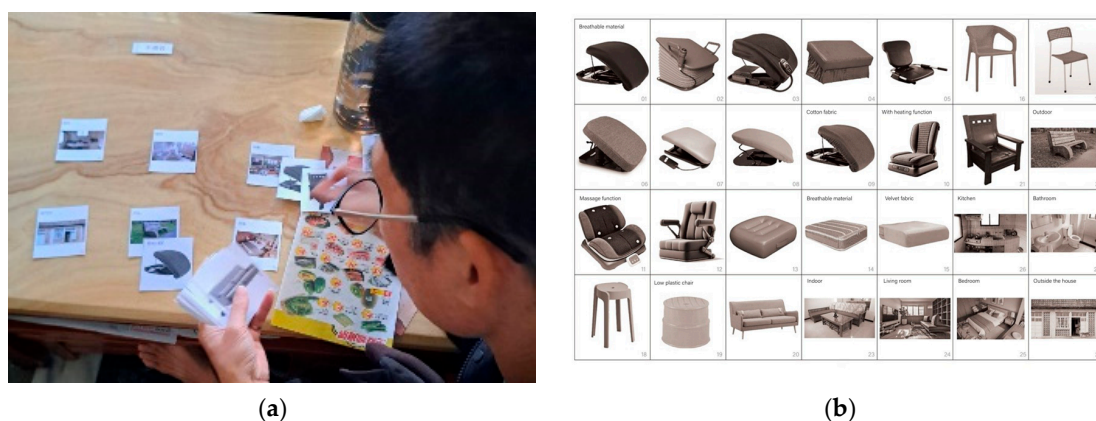


Figure 2. (a) Sample card screening process and (b) illustrations of different cushions, scenarios, and chairs using cushions.

3.2. Interviews and Empathy Mapping in EGM

We invited 10 users with over one year of experience using assistive seat cushions to participate as subjects in the EGM interviews. The participants ranked and compared the samples based on their preferences at three levels: liked, neutral, and disliked. These were

further classified into seven levels: most liked, liked, somewhat liked, neutral, somewhat disliked, disliked, and most disliked. The participants explained the meaning of their rankings of each cushion, as shown in Figure 3. The interviewers organized the responses to identify the middle level (original evaluation items), upper level (abstract concepts), and lower level (specific conditions) in the EGM structure. Additionally, an empathy map was created based on the findings.



Figure 3. Respondents rank sample cards based on their level of preference.

3.3. KJ Method for Screening

To systematically organize the participants' feedback and identify common evaluation criteria, we applied the KJ method to visualize the structural evaluation result of assistive seat cushions. This approach aimed to better understand the popularity and specific characteristics of assistive seat cushions among different users. The process involved compiling vocabulary from the in-depth interviews of 10 participants, performing frequency accumulation, and categorizing the upper level (abstract concepts) and middle level (specific conditions). A screening process was conducted with the assistance of one expert with 10 years of industrial design experience and three graduate students from an industrial design program. The results of the KJ method are illustrated in Figure 4.

Top-level KJ					
Stable and reassuring	Comfortable and pleasant	Continuous and stable	Simple and elegant	Flexible and practical	Stability and belonging
Independence*7 Stability*14 Sense of security*8 Peace of mind*12 Dependence*5 Reduce fear or anxiety Assurance*7	Relaxation*8 Stress relief*5 A feeling of warmth and support*4 Pleasure*3 Ease*6 Satisfaction*7 Naturalness*13	Durability*15 Cost-effectiveness*2 Continuity Stability*9	Elegance*5 Harmony*2 Aesthetics*5 Appeal*6 Simplicity*4	Practicality Diversity*5 Flexibility Efficiency*2 Adaptability*8 Functionality*13	Sense of belonging Sense of stability Confidence Dignity Joy
Middle-level KJ					
Secure protection	Comfortable support	Durable and reliable	Design aesthetics	Peaceful and harmonious	
Anti-fall design*8 Center of gravity stability Anti-slip design	Support effectiveness*7 Relaxation during use*2 Even pressure distribution on seat and legs*4 Synchronization of back and lumbar support Cushion conformity	Durability*5 Scratch resistance of surfaces Usage rate of durable materials Ease of component replacement*5 Reduction in failure rate during use	Consistency in design style Harmony in material combinations Simplicity of appearance*5 Fineness of detail Compatibility with home decor*5	Sense of reassurance during use*4 Integration of the product into living scenarios Safety from a sense of familiarity*5 Psychological relaxation during use*3 Design that meets age group aesthetics	
Agile control	Health protection	Environmental adaptability	Easy operation	Sense of belonging	
Flexibility of angle adjustment*2 Practicality of auxiliary functions Ease of operation design*3 Compatibility of additional features	Alleviation of skeletal pressure through support Design to prevent muscle stiffness*4 Functionality to reduce joint strain Pressure reduction effect Minimal impact on the body from long-term use	Materials suitable for various temperature conditions Compatibility for indoor and outdoor use*2 Easy-to-clean surface design*4 Dust and stain resistance	Ease of use for buttons and knobs Ease of installation process*2 Intuitiveness of user instructions Smoothness of function switching Stability during operation*4	Sense of belonging during use Emotional factors that evoke memories Satisfaction from long-term use Visual and tactile pleasure	
Bottom-level KJ					
Anti-slip silicone bottom design*3 Handles with soft padding*2 Raised edge protective design Reduced metallic appearance	Multi-layer breathable hole structure Adjustable lumbar support*2 Replaceable armrest and backrest modules Sweat-wicking design*3	Replaceable cushions*4 Simple appearance Easily movable seat cushion Compact design*4	Simple step operation Stable armrests*6 Easily replaceable parts*2 Rounded shape	Easy to clean With armrests*8 No electricity required*7 Easy to store	Simple and easy-to-understand icons*8 Self-operable*5 Adjustable preference memory Curvature conforms to the hips

Figure 4. KJ method for vocabulary summarization; “*” indicates the number of mentions.

4. Results and Discussion

4.1. EGM Interview

Based on the results of the EGM interviews, the vocabulary provided by each participant was categorized and grouped. Using EGM, the terms were organized into three levels: upper level (abstract concepts), middle level (original evaluation items), and lower level (specific conditions). Relevant terms were grouped to create a structured representation of each participant's

individual needs. Corresponding individual EGM diagrams were developed to understand each participant’s perspectives and suggestions regarding assistive seat cushions (Figure 5).

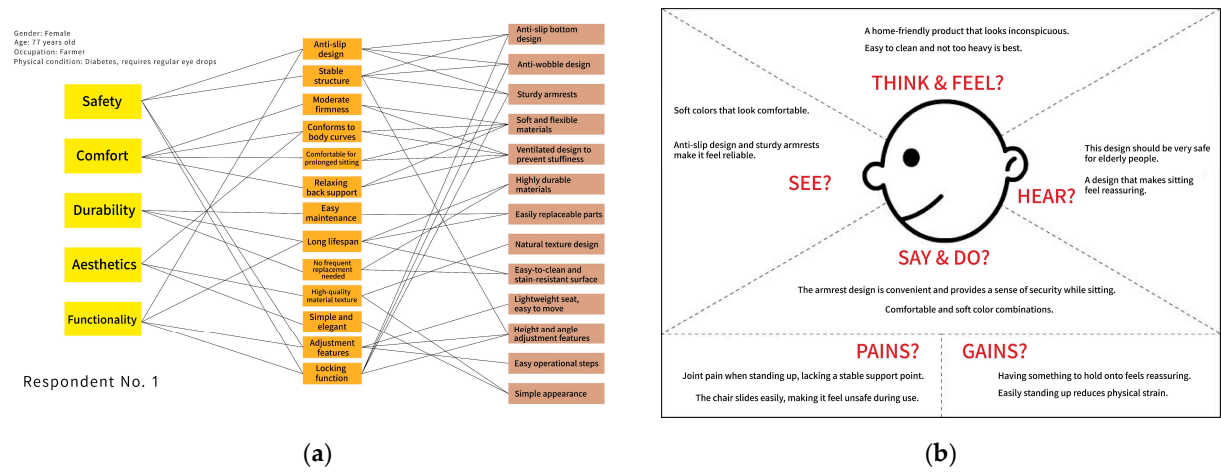


Figure 5. (a) Interview feedback from (EGM) and (b) empathy map summaries.

To further explore participants’ needs, pain points, and expectations, we created an empathy map for each participant. The empathy maps captured what participants “heard”, “saw”, “said”, and “felt” while using assistive seat cushions, supplemented with descriptions of their “Pains” and “Gains.” This comprehensive analysis, from both emotional and rational perspectives, enriched the results of the EGM analysis and provided deeper insights into the user experience.

4.2. Consolidated EGM Results

Based on the interviews with 10 users of assistive seat cushions (Figure 6), “stability of the cushion” and “sense of security during use” were identified as the most critical factors regardless of differences in their backgrounds or physical conditions. Among the mentioned features, the presence of armrests was cited most frequently, highlighting their significant role in enhancing user safety and convenience.

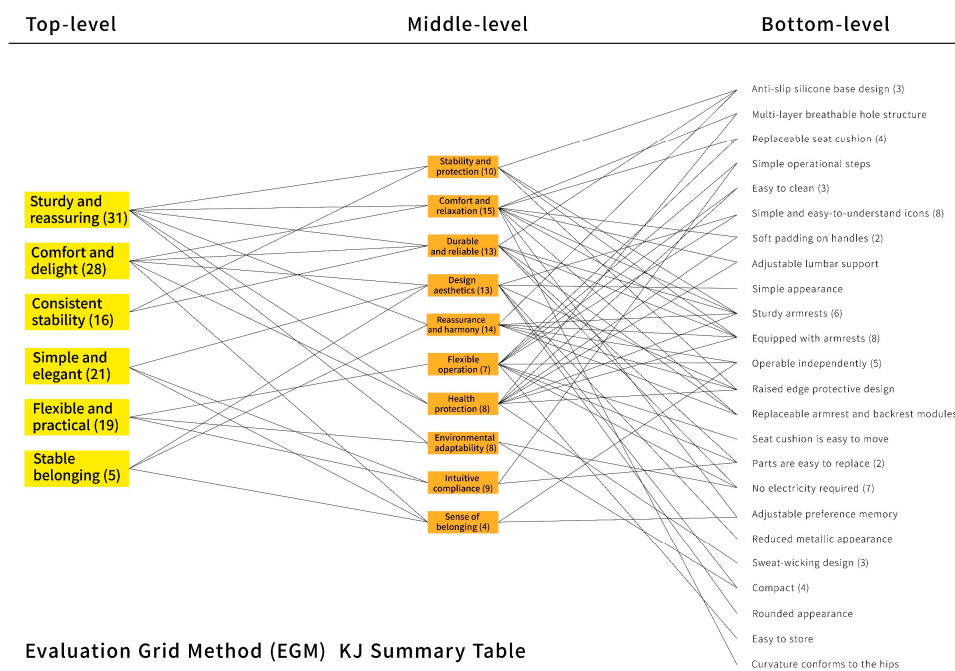


Figure 6. KJ method master table.

4.3. Consolidated Empathy Maps

Through feedback from the participants, we summarized the needs and expectations of elderly users regarding assistive chair design in daily life (Figure 7). In-depth interviews and an empathy map analysis of the 10 participants revealed diverse requirements influenced by varying physical conditions, occupational backgrounds, and personal habits. The participants were coded A to J for clarity.

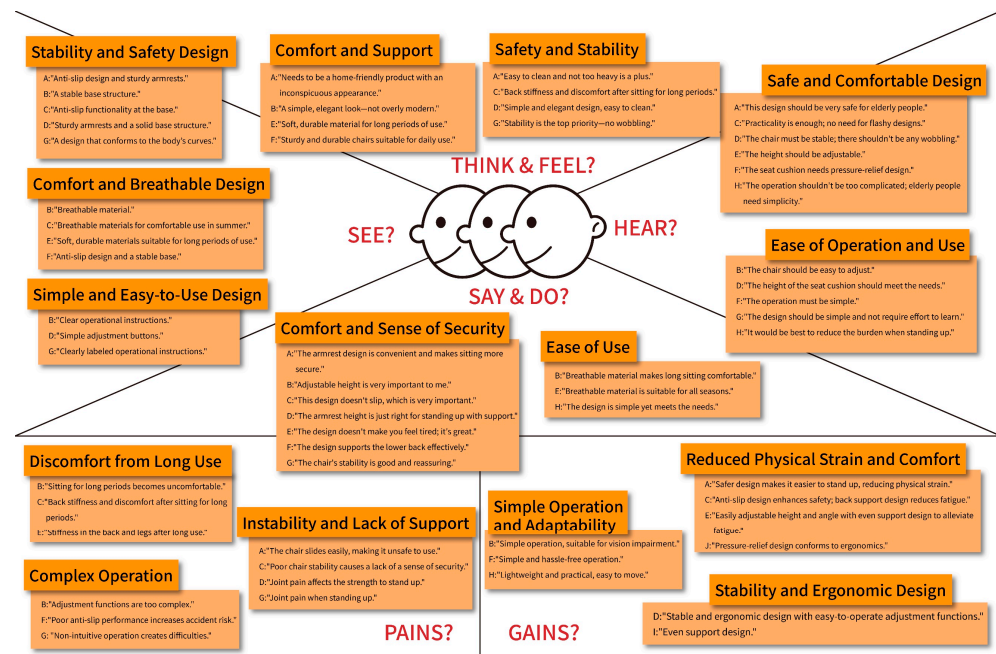


Figure 7. Empathy map master table.

- Safety and stability as primary needs: Most participants emphasized that chair stability and anti-slip design are the top priorities, particularly during the process of standing up. Stable support effectively reduces physical strain and minimizes the risk of falls. For example, Participants C and F specifically stressed the importance of “stable armrest design” and “anti-slip bases.”
- Ergonomic and comfortable design: Many participants expressed a desire for seat cushions and back supports designed to alleviate fatigue from prolonged use. Participants E and H mentioned that insufficient back support led to stiffness and discomfort, while Participants C and G highlighted the significance of breathable cushion materials, particularly for comfort during summer.
- Multi-functionality and adaptation to life scenarios: Feedback from participants showed the necessity of balancing multifunctionality with daily usability. For instance, farmers and retired workers prioritized durability and robust materials, while community volunteers and homemakers preferred designs compatible with home environments and easy to clean. These responses reflect the diverse demands for multifunctional designs based on user backgrounds.

5. Conclusions

Using EGM, we explored the usage experiences and preferences of elderly users regarding assistive seat cushions. The elderly particularly valued the stability of the cushion, the design of armrests, and the anti-slip features (Figure 8). Additionally, ergonomic comfort and multifunctionality significantly determined their preferences. Through in-depth interviews and KJ method analysis, the psychological needs and specific design features desired by elderly users were identified, providing a reference for product design

and improvement. The empathy map highlighted core needs and expectations when using assistive devices, such as safety, reducing fall risks, and enhancing autonomy. Based on the maps, the most frequently mentioned feature, “stability and security” (mentioned 31 times), was selected as the primary design goal. Based on the results of this study, the following recommendations are proposed.

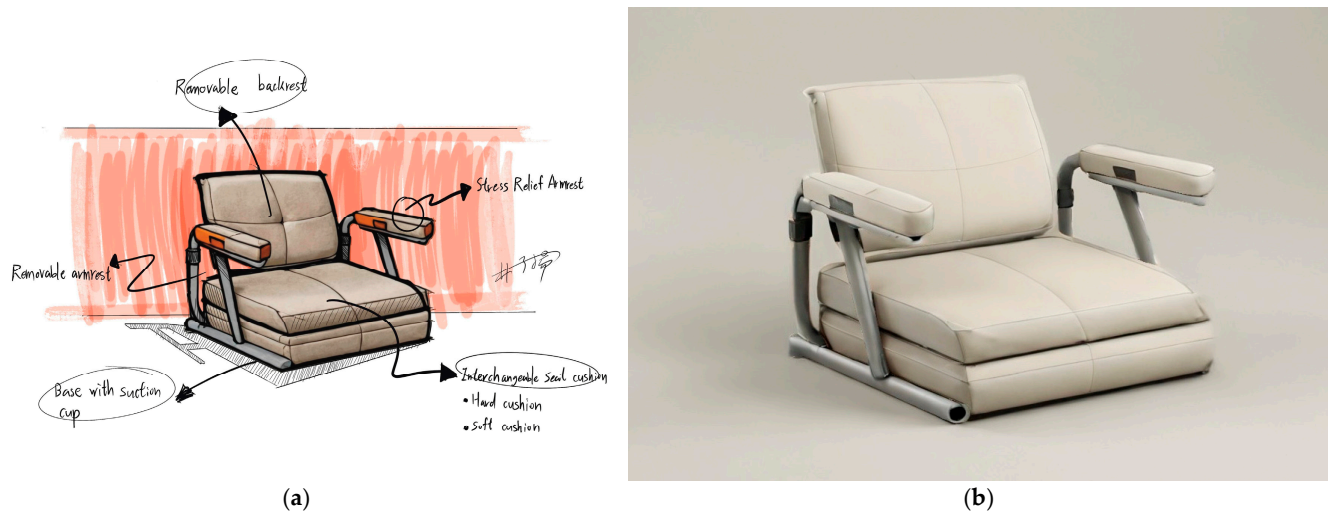


Figure 8. Product sketches (a) and product simulation images (b).

- **Integration of armrest and stable support:** In the design of assistive seat cushions, combining armrests with stable support must be emphasized to enhance safety and a sense of security. This aligns with the “stability first” need identified in the empathy maps.
- **Material selection for comfort and durability:** Breathable and durable materials must be used to accommodate different climates and prolonged use, addressing users’ demands for “comfort and durability”.
- **Incorporate adjustable features:** Adjustable functions must be adopted to meet the needs of users with varying body types and usage scenarios, particularly in diverse environments such as homes and community settings.

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