

## RESEARCH ARTICLE

# Empowering Elderly Women with Osteoarthritis Through Hands-On Exploration of Adaptive Equipment Concepts

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## Abstract

The study investigated the participation experiences of elderly women with hand limitations in a maketools-inspired activity for improving bottle openability and verified the usefulness of the results from this approach. Participatory design was used to stimulate participants' hands-on fabrication of new bottle lid concepts. Air-dry modeling clay, Crayola Model Magic<sup>®</sup> (Crayola LLC, 1100 Church Lane Easton, PA 18044-0431), clay modeling tools sets and empty bottles were the tools used to explore feasible and user-envisioned ideal lids that could potentially reduce hand pain and improve function when opening bottles. Twenty-five elderly women fully participated in the study. They generated 36 bottle lid design concepts. Qualitative analysis identified inclusion of four primary design features as follows: 1) surface texture; 2) increased leverage through lid shape or diameters; 3) increased contact surface with palm/fingers through lid shape or height; and 4) facilitation of alternative grip types. The major limitations of the study were inclusion of only women participants and healthier persons living in a retirement community. Future research is needed to investigate the bottle lid preferences of men and persons with more severe hand function living in places other than independent living communities. Copyright © 2013 John Wiley & Sons, Ltd.

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## Keywords

activities of daily living; arthritis; hand; patient participation; empowerment

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## Introduction

In the United States, the proportion of the population aged  $\geq 65$  years is projected to increase from approximately 40.2 million in 2010 to an estimated 72 million in 2030 (U.S. Census Bureau, 2008). The effects of aging are associated with marked declines in motor function for many elderly adults (Yen *et al.*, 2011). Hunter *et al.* (1998) suggest that changes in hand function are due to deterioration in muscle coordination,

finger dexterity, hand sensation and degeneration of the central nervous system. In addition to the aging process, chronic diseases such as hand osteoarthritis (OA) contribute to reduced effectiveness in hand function (Carmeli *et al.*, 2003). Most elderly individuals with hand use limitations have experienced difficulties in performing one or more activities of daily living (ADLs) when interacting with products in their living environments (Bellamy *et al.*, 2002). Opening a new jar or bottle is one of the most difficult ADLs for the

elderly population (Bellamy *et al.*, 2002; Voorbij & Steenbekkers, 2002; Yoxall *et al.*, 2006). There has been a number of lid design studies conducted in the last two decades. However, the majority of them have focused on healthy young adults and the forces they require to open a jar (Pataky *et al.*, 2007; Chang *et al.*, 2008; Kuo *et al.*, 2009; Su *et al.*, 2009; McKee *et al.*, 2011). Studies with elderly adults have investigated the maximum voluntary torques that are needed to open a jar or bottle when lids have different textures, diameters, heights and shapes (Imrhan & Loo, 1988; Crawford *et al.*, 2002; Yoxall *et al.*, 2006). Although elderly individuals have been included as participants in these studies, none have included persons with known hand limitations in opening jar lids or with reported hand pain at the time of the study. More importantly, suggestions for improving openability of lids from this cohort have not been examined.

Occupational therapy professionals are skilled in providing client-centered assessment and intervention (Law, 1998). In a client-centered approach, a client provides potential solutions for managing his or her own meaningful challenges, such as opening jar lids. When the client is making and using objects, the occupational therapy professional can analyse the characteristics for activities; structure and form, physical properties, action processes, outcomes and symbolic dimensions (Fidler & Velde, 1999). The physical properties of an object then are used to create an end product which has socio-cultural and personal meanings. Therefore, potential benefits in product development can be realized from involving clients in the process and in analysing the common design features created by them.

Jack & Estes (2010) have reported that occupational therapy professionals are predominantly using a biomedical approach to rehabilitating persons who have orthopedic conditions such as hand OA. This approach promotes the use of mechanical skills by occupational therapy professionals instead of a balanced plan of care which incorporates the goals and recommendations of persons seeking resolution of their complex performance limitations (Law *et al.*, 2002; Jack & Estes, 2010). A typical intervention from this type of practice is the use of adaptive equipment as the primary compensation for activity limitations. Many commercial devices are available for persons with limited hand function in opening bottles. A study by Kraskowsky and Finlayson (2001) found that only 82% ( $n = 47$ ) of all prescribed equipment continued to

be used by older adults, with utilisation continuing to decrease over time. In another study, non-compliance in using adaptive equipment has been reported to be as high as 78% for clients post-hip replacement due to little to no involvement in the decision-making process (Thomas *et al.*, 2010). For adaptive products to be fully accepted, the usefulness, usability and desirability needs of end-users must be addressed (Sanders, 1992; Arthanat *et al.*, 2010). A hands-on approach to fabricating one's own adaptive equipment during occupational therapy treatment would identify the unique needs and recommendations of the user and thereby improve the potential acceptance and compliance for the device. In addition, this process would enhance the adaptive skills of persons who are faced with activity limitations resulting from changing hand function (Cynkin & Robinson, 1990; Breines, 1995). Most importantly, client adaptation is fostered and improved patient outcomes are maximized (Chan & Spencer, 2004). The difficulty lies in finding a mechanism to assist occupational therapy professionals in expanding the commonly applied biomechanical approaches of rehabilitating orthopedically diagnosed clients with a balanced approach that includes client-centered and occupation-based intervention.

Over the past 10 years, the design development domain has experienced a parallel trend towards people-centered approaches and the involvement of consumers and end-users in the creation of products that are useful, usable and desirable. For example, Participatory Action Research (PAR) has been suggested as an approach to empower participants to test new ideas and to implement change in solving everyday problems (Hult & Lennung, 1980; Checkland & Holwell, 1998; Dick, 2002). Key aspects of this approach have been described by Kindon (2007). As a blend of research, education and action, participants play a role in providing the values and beliefs indigenous to a specific group. All members are viewed as competent in all aspects of the research process. Common methods used in PAR are dialogue, storytelling and community art. A consistent theme of this approach is the "hands-on" nature of the group work and the use of participants' own symbols, language or art forms. Theory emerges from an iterative cycle of practical interventions, actions and reflections. New knowledge is generated through collaboration between participants and researchers. The credibility of this knowledge is based on how well the resulting action serves to

address the problems of the persons involved in the study and the representative community at large.

A very recent trend in participatory design (PD) can be seen in cases studied from the field in which the approach is being used to improve the well-being of people living with disabilities and/or challenges along a number of dimensions including physical, cognitive, social and psychological. For example, Van Rijn (2012) co-designed with autistic children and their caregivers, Hussain and Sanders (2012) collaborated with children in Cambodia living with prosthetic legs, Loventoft *et al.* (2012) adapted PD methods with adults living with depression, Galliers *et al.* (2012) with those living with aphasia and Obata *et al.* (2012) used PD with the elderly.

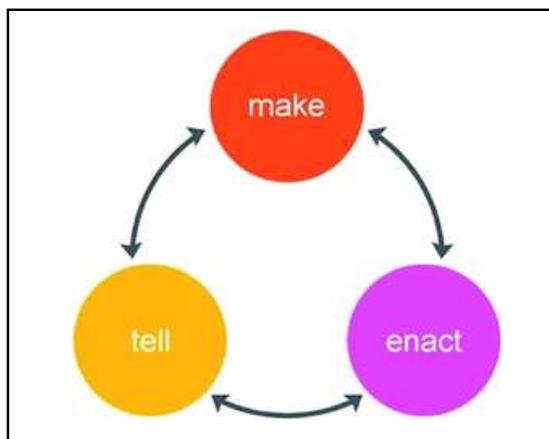
Because of the expansion of PAR within various fields of study, several approaches have been developed within PAR that use similar components but eliminate research in the title due to traditional connotations and abstract meanings of that term for many community and group members. PD is an example of an emerging design practice that involves non-designers in the co-creation of products, systems and services that are useful, usable and desirable (Sanders, 1999; Sanders *et al.*, 2010). On the basis of a theoretical foundation, the focus of PD is on the people being served through design (Sanders & Stappers, 2012). In PD, the end-user is respected as a participant in the process, one who contributes as an expert in his or her experiences of living. Results suggest that end-user participation in design leads to more useful products, spaces and services as well as feelings of ownership by the participants in the end results. Others, such as product development stakeholders from engineering and marketing, are typically included in the co-designing activities (Ramaswamy & Gouillart, 2010). This ensures that the product, system or service can be realized.

An important way to access participants' experiences in PD is through the use of making things, telling stories and enacting possible futures (Sanders *et al.*, 2010). These concepts describe a PD framework used to link theory to practice called the *making, telling and enacting* model. The model combines the three activities in an iterative and never-ending loop. It provides a focus point for treatment; a way to understand and to plan for participatory activities. One activity leads to and enriches the next activity. For example, people can begin by making things and then enacting with these things to express their ideas and dreams about future scenarios of use. Or they can start with telling a story about the future and then make props to help make

the story come alive as they enact it. Figure 1 provides the schematic of the making, telling and enacting framework.

The activities and materials for the making portion of the model are referred to as *maketools*. As a development in design research, maketools is a "design language" for users, not just for designers (Sanders, 1999); a design language that is built upon the aesthetics of experience rather than on the aesthetics of form. Unlimited types of activities and materials can be used. In the current study, participants were given a hands-on experience of constructing future bottle lids for people who are living with hand OA, using clay and clay modeling tools. Consequently, the participants started with making a product and finished with telling a story about it. Because of the nature of the soft clay used to make the bottle lids, a rudimentary form of enactment was used, that of "pretending". Thus, the bottle lid presentations typically included a story about the bottle lid concepts with the elderly women using gestures to demonstrate how opening the lid would actually work in future applications.

Participatory design has vast potential in enhancing the design of new products, systems and services and also in understanding the experiences of potential occupational therapy clients. Therefore, the specific aims of the study were 1) to explore the participation experiences of elderly women with hand limitations in a maketools-inspired activity for better understanding of bottle lid openability and 2) to verify the usefulness of the results from this approach.



**Figure 1** Schematic of the making, telling and enacting model

## Methods

### Study design

The study described here was part of a larger mixed methods study investigating jar and bottle lid design features that improve the experiences of elderly women with hand impairment (Yen, 2011). In addition, human factors design assist tools were identified that satisfy the practical needs of industrial designers when solving design problems such as opening and closing jar and bottle lids. For examples of other design assist guidelines, consulting Woodson *et al.* (1992) and Neumann (2007). In the portion of the study described herein, qualitative methods used a maketools-inspired activity where participants with hand limitations were given the opportunity to make their own best bottle lids. Other data collection methods included open-ended interviews and participant observations.

### Participant selection

Participants were recruited from five retirement facilities in Central Ohio. Participation was accomplished by getting permission to post flyers about the session in various locations within the retirement homes. In three facilities, a short announcement about the study was made at a facility meeting and the investigator was available to answer questions and enroll interested participants. In two facilities, interested participants contacted the facility manager or the investigator directly. All participation was carried out on a voluntary basis. The sessions took place in the retirement facility in which the participants lived.

The eligibility criteria of this convenience sample included being female, 65 years of age or older, having difficulty in opening jars or bottles with twist-off lids, self-reported hand pain and ability to follow verbal directions. Elderly women were recruited for the study because being female was identified as one of the highest determinants of hand disability in the elderly population (Dahaghin *et al.* 2005a; 2005b). Being the first study of the ergonomic needs of the elderly population in opening bottle with twist-off lids, it was decided that a focus on those participants most in need of intervention should take place.

### Procedures

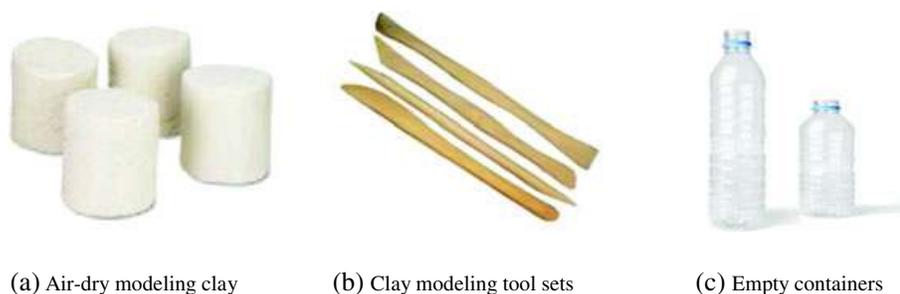
The study received ethics clearance from the Behavioral and Social Sciences Institutional Review Board at The

Ohio State University. Informed written consent was obtained from each participant. The entire process was explained to them before they began and they were informed that they would be able to leave the study at any time if they did not want to continue. The researcher let the participants set the pace in the various activities planned for the session.

First, an assessment of 42 commercially available jar lids was performed during a 1-hour focus group. Participants rated their preference for jar lid sizes, shapes and textures. Thus, the participants were at this point fully immersed in thinking about what makes lid designs good or bad. Results of this study are reported in a separate publication.

The focus group was followed by a maketools-inspired activity that took place in smaller groupings of 3–5 women. The purpose of this activity was to introduce the core concepts of the making, telling and enacting model and to facilitate the creation of new lid concepts that would reduce hand pain and improve the participant's ability to open bottles. The investigator conducted a maketools-inspired activity wherein the subjects received a toolkit to make their own ideal bottle lids. The contents of the toolkit contained air-dry modeling clay, for example, Crayola Model Magic<sup>®</sup>, clay modeling tool sets and two empty containers. Because all of the elderly women complained of hand pain, soft clay and a weighted plastic bottle were selected for this portion of the study to improve hand grasp and safety in manipulating these objects during the length of the maketools-inspired session. Figure 2 shows the materials used in the design toolkits. Crayola Model Magic<sup>®</sup> was selected for this study as it was easy for the participants to use, was cost effective and did not introduce additional variables such as color, texture or odor.

The participants were instructed to work individually to create the “best” lid design with consideration of their own limitations in hand use, discomfort and use of favorite sizes, shapes or surface textures. This represented the process “making” described in the making, telling and enacting model. They used clay to produce rough prototypes of new bottle lids and to explore solutions for opening bottle lids more effectively. To stimulate the capacity of the participants in producing various levels of design ideas, they sequentially completed a series of two design tasks. The instructions for the first task encouraged incremental design ideas by asking them to make “the best lid design that you might see in the



**Figure 2** Materials used in the maketools design kit

market within a couple of years”. The instructions for the second task encouraged blue-sky design ideas by asking them to make “your craziest or blue-sky idea for a new lid. It could be any shape, any size or any type of lid in the future”. Following the instructions, participants added clay to the empty containers as caps and then shaped them as desired.

After the design workshop activity, each participant was invited to present and explain her lid concept(s) to the rest of the group. Participants were asked to *tell* how their lid prototypes were useful, as if they were selling their new idea to a company that might be a likely future product manufacturer.

### Data collection and analysis

The design lid prototypes from the maketools-inspired activity were collected and photographed. Audio and video data recordings were made during the sessions as well. Making the lids provided a way for the participants to express their latent needs which may have been difficult to express in words alone.

Detailed notes by the investigator were made on the presentation portions of the audio records of the workshop. These data were analysed to supplement the expressions of design features on the desirable bottle lid prototypes. Analysis of this type of mixed data is discussed in Sanders & Stappers [2008]. The re-occurring bottle lid design features that were identified from the participants’ design artifacts and mentioned in their presentations were then categorized by the researcher based on visual characteristics. Two additional investigators from the study categorized the bottle lids at the conclusion of the study to ensure credibility and transferability of the data results. Photos of all the design artifacts can be seen in Figure 3.

### Results

Twenty-six female participants were recruited and completed the maketools-inspired activities. The mean age was 84.8 years with a standard deviation  $\pm 4.96$  years and ages ranging from 74–96 years. The cohort lived independently in one of the five retirement facilities in Central Ohio. About 85% ( $n=22$ ) of the subjects reported being right-hand dominant, 12% ambidextrous ( $n=3$ ) and 4% ( $n=1$ ) left-hand dominant. A total of 88% ( $n=22$ ) used their right hand to open bottles. About 80% ( $n=22$ ) reported hand pain in the past month with only 12% receiving treatment for arthritis.

Thirty-six designs were generated by the participants from the maketools-inspired activity. Figure 3 contains photographs of the lid design artifacts produced by the participants.

Among the subjects who participated, only one subject had difficulty making her lid artifacts. The other 25 elderly women had no problems with getting started or finishing within the time allotted, which was planned to be about 30–45 minutes. In fact, they were quite excited to take part in the activity and had fun in doing so. The participants were eager to present their ideas and expressed pride in their lid concepts as well. They looked very confident when presenting and “selling” their ideas. The entire session, including the making of two lids and presentations, took about 30 minutes. It is important to keep in mind that the evaluative activities that took place in the first part of the session were helpful in immersing the participants in thinking about what kinds of lids they preferred and found easy to use.

Categories were developed on the basis of a qualitative analysis of the lid prototypes and descriptions of them given by the elderly women. Independent



**Figure 3** Lid design artifacts produced by the participants

rankings by the two investigators supported the findings of the original investigator. The participants were found to 1) add texture onto lid surfaces; 2) increase leverage by changing lid top shapes or diameters; 3) increase contact segments or surface areas with palm/fingers by redesigning lid side shapes or heights; and 4) propose brand new lid designs to facilitate alternative grip types. After counting the numbers of re-occurring design features, both “increase leverage” and “increase contact surface with palm/finger by changing lid heights” were found in 61% of the 36 design artifacts, followed by “add texture” in 58%, “increase contact surface with

palm/finger by changing lid shape” in 39% and “facilitate alternative grip types” in 19%.

## Discussion

The aim of the study was to investigate the participation experiences of elderly women with hand limitations in a maketools-inspired activity for improving jar openability and to verify the usefulness of the results from this approach. Twenty-six elderly women with known difficulties in opening jars or the presence of hand pain were included in a study with ergonomic and product

design research methodology. PD was applied through a maketools-inspired activity which provided hands-on experience in fabricating concepts of user-friendly bottle lids. This process was useful for accessing the participants' unspoken feelings and ideas about their desirable lid designs.

All but one subject were able to complete the study. Well-established constructs, developed by PD research experts, apply a valid frame of reference for occupational therapy called the making, telling and enacting model. As an individual or group activity, the experience provides therapeutic benefits to the client in using available hand movements, creative problem solving and social engagement. According to Zimmerman (1995), psychological empowerment comprises intrapersonal, interactional and behavioural components. He makes a distinction between empowering processes and empowered outcomes. The first refers to how people, organisations or communities become empowered, whereas the second refers to the consequences of those processes. These two perspectives on empowerment can be observed in this study as well. The maketools-inspired activity was an empowering process with potentially empowering outcomes (i.e. the lid concepts).

In this study, clay served as the medium to explore new bottle lids. However, other supplies are readily available in occupational therapy clinics. Examples include putty, splinting materials, plaster impregnated strips, coban<sup>®</sup>, otoform<sup>®</sup> and the introduction of new supplies such as Sugru<sup>®</sup> (<http://sugru.com/us>), an air-curing rubber, which can be used for making lids that actually work. The use of Sugru<sup>®</sup> is recommended as the medium of choice over other materials for exploring new bottle lids in future research on maketools-inspired activities. The participatory session would need to take place over 2 days so that the Sugru<sup>®</sup> lids would have time (at least 24 hours) to cure. However, once cured, the new lid concepts could actually be used, enabling a far more robust application of enacting in the making, telling and enacting framework. In addition, the concepts could be put into use in the participants' lives.

The maketools-inspired activity can be readily adapted to other products that people with hand limitations may have trouble using such as keys, utensils, cell phones and other hand-intensive devices. The perception of using maketools-inspired activities may look like "arts and crafts" which can appear to be less rigorous and scientific. However, the focus is

on using a PD approach that involves a client in prototyping new ideas and in making his or her own life better. This way of working acknowledges the client's expertise and gives him/her an important role in adapting the products and devices that they use in everyday living and likely increases the probability that these products and devices will be adopted and used by the client. In addition to improving occupational performance, clients can be empowered to take more active roles in the therapeutic relationship and for their overall well-being. This is an important step in achieving the vision of Dr. Mary Reilly, "Man, through the use of his hands, as they are energized by mind and will, can influence the state of his own health" (Reilly, 1961, p. 2).

Finally, the four design feature categories that were observed in the prototype lids supported the characteristics identified by Seo *et al.* (2007). Improving leverage, increasing grasping surface of objects and adding texture were generated by a majority of the elderly women. In addition, design-changing lid shapes and designs supportive of developing alternative grips were generated by smaller groups of participants. The findings support this cohort's ability to produce potentially useful, usable and desirable adaptation concepts for themselves; it is generally assumed that these designs would also support the hand function of the broader population of consumers who manipulate jar and bottle lids though formal evaluation would be recommended to verify this. In addition, the lid features supported common joint protection techniques provided by occupational therapy professionals to persons with arthritis (Cooper, 2006). Several participants designed a taller and bulkier lid that supports the principles of using larger, stronger joints of the fingers and thumb. These same enlargements and the addition of texture reduce the force applied by the thumb to open the jar. Proper alignment of the thumb in abduction and opposition is encouraged with the participant's enactment of increased levers and shapes.

### Limitations

By design, elderly women were recruited for the study, which limits the generalisability of the results. Subject selection was based on gender differences reported by Dahaghin *et al.* (2005a; 2005b). Being female was identified as one of the highest determinants of hand disability in the elderly population. Furthermore, Fransson-Hall & Kilbom (1993) reported that healthy

women experienced pain faster than men when exposed to sustained, externally applied surface pressures. The areas of highest sensitivity were in the thenar area of the thumb and the skinfolds between the thumb and index finger, all contact areas needed when opening a jar. Therefore, women with hand pain were expected to be more sensitive to the variations in lid design. Future studies should investigate the best lid designs preferred by males to compare possible differences by gender.

Another limitation was the potential selection bias that may have been inherent in the participant recruitment process. It is possible that elderly persons with severe hand problems are not residing in retirement communities and/or not willing to participate for the study due to reluctance in exposing their hands to additional use. Therefore, the study participants may limit generalisability to the population of women over the age of 65 years who are living independently in the community or those persons with varying levels of OA severity.

Finally, the maketools-inspired activity was preceded by a focus group in which the participants rated commercially available jar lids. This exercise was conducted to help the participants become aware of and be able to voice their thoughts about the characteristics of lids. An immersion activity such as this usually primes the participants for the creative maketools activity (Sleeswijk Visser *et al.*, 2005). In this study, the bottle lid designs created by the participants did not resemble those of the existing jar lids evaluated from the same participants in the focus group. However, information from the focus group may have biased the bottle lids that were created during the maketools-inspired activity.

## Conclusions

The study supports the use of the making, telling and enacting model of product development as an effective and complementary method for implementing client-centered and occupation-based intervention for persons with hand limitations. Empowering clients in a hands-on, enjoyable experience of fabricating adaptive equipment has the potential to improve adoption of occupational therapy intervention through lifestyle modification with adaptive devices, health promotion of occupational performance and disability prevention due to hand impairment. Engagement of targeted user

groups in the creation of solutions that address ADL challenges can produce potentially useful concepts for challenging occupational performance limitations, input for inclusive product designs and positive psychosocial experiences for the participants.

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