Human Factors Design Of A Group Activity For People With Dementia

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Abstract—The Memory Magic™ Program was developed as a group activity for persons with dementia. Using Montessori principles and human factors research, we designed the activity to successfully engage individuals with varying levels of cognitive and physical ability. The design process began with testing of a number of design parameters to determine which design structure was most ergonomically sound and would best accommodate visual and perceptual deficits common to aging and dementia. As a result of the pilot testing, a prototype design for the activity was developed and 15 models were constructed. The models were then tested in long term care, adult day care, and assisted living settings. Results indicate that The Memory Magic™ Program elicited more positive engagement, improved affect, and a reduction of negative behaviours in 24 participants.

I. Introduction

A model intervention, called the Memory Magic™ Program (See Fig. 1) provides an example for expanding and innovating beyond the activities for individuals with cognitive impairments available today[1]. This model provides a challenge to activity professionals and researchers to extend new concepts to group settings that can be easily integrated into activity and therapy programs. As more activities are available and adopted in care settings, such considerations go a long way to helping match caregiver demand requirements with staffing[2].

Older adults do not show performance decline in all tasks; however, persons with dementia have unique needs that must be addressed when developing activities for this population. Human factors research contains a rich collection of data specific to older adults that can greatly improve the effectiveness of product design. A review of the literature indicates a vast collection of findings regarding human-computer interaction and topics such as Smart Houses, but very little in relation to enhancing therapy delivery for persons with dementia through product design.

Fig. 1. Ten residents of a dementia unit are engaged in social interaction supported by the prototypes of the Memory Magic™ Program materials. The individuals are asked to read an incomplete sentence, usually a familiar phrase, where the completing word may be in one of the windows on the board in front of them. Each card is unique, like BINGO. Each card has 9 answers of the 15 questions or rounds in each session.

The specific aims of the research involved developing a group therapy for persons with dementia in the form of an activity. The activity was to be structured to be effectively engaging for persons across a wide range of stages for dementia. The resulting program, Memory Magic™, was initially designed as a card game. In the first manifestation, players were presented a set of index–size "answer cards" on which were typed words belonging to a particular category. The typed words were bold and in large print with sans serif font to accommodate visual and perceptual deficits common to aging and Alzheimer's disease. Examples of categories used included TV shows, household items, and song titles. Players had a set of four answer cards placed in front of them (e.g., "Have Gun, Will Travel" "Father Knows Best" "Playhouse 90" "The Honeymooners"). The activity staff persons running the activity would then hold up a "calling card" and ask a player to read it out loud (e.g., "Gunsmoke"), rotating the reading task among the players. If anyone had the matching answer card in front of them, they turned it over so that the answer card was showing its blank side. This continued until someone had all blank cards, at which time a "Bingo" was declared and a prize awarded. Cards were then taken up, and a new set of

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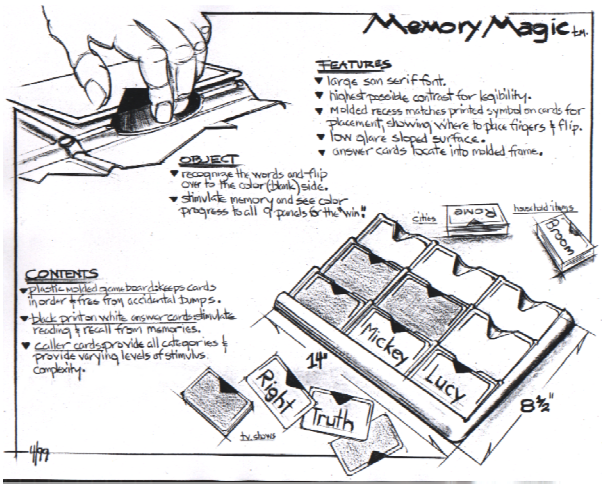

Fig. 2. The initial concept for The Memory Magic™ Program was a card game. Players would place the cards on the plastic board at the start of the game. As each answer was used the cards would be turned over. The board's form changed significantly, but the activities content and core concepts are represented in the drawing above.

answer cards representing a different category was distributed. Generally two to three games were played within an hour's time, occupying up to eight persons with moderately advanced dementia. We also found that clients could utilize varying levels of complexity in the content of calling cards. Examples include: matching the word on the calling card to a word on an answer card (moon—moon), completing a sentence or phrase (Shine on harvest—moon); or answering a question (Neil Armstrong was the first person to walk here—moon). Thus, the content of the games could be matched to the level of dementia seen in players, with easier stimuli used for more advanced dementia. As shown in Fig. 2, we had initially intended for the commercial version of the activity to continue to use cards, but with a special holder for the cards. As envisioned, players would take individual cards and place them in a plastic card holder designed to be able to fit on a lap or table top.

II. Determining Initial Design Features

To begin development we set out to test a number of design parameters for the product to determine if our initial conceptualization of the activity was viable. Key issues to decide included: 1) Size of the cardholder; 2) to use/not use individual cards; 3) the number of answers per game; 3) probe questions; and 4) the size of print on the cards.

In order to accommodate as many potential players as possible, we wanted to enable persons in wheelchairs to play, especially if a dining table or over–bed table was not available. Therefore, the cardholder had to be of an appropriate size to fit in the lap of a person in a wheelchair. After examining a number of different types of wheelchairs, we determined that the cardholder could not be wider than 15 inches in order to fit between the arms of the smallest wheelchairs we examined.

A major decision regarding the product design involved whether to use individual cards for each answer or to incorporate a single sheet on which all answers would be printed. The benefit of using individual cards is that it requires that participants manipulate objects each time that an answer is found. The manipulation of materials is a central concept in Montessori-based activities (Camp, 1999 a, b).

However, activities therapists interviewed during pilot testing stated that setting up a game that required individual cards for each answer for each of 20 or more participants would take an inordinate amount of time to set up properly, and that it was very likely that cards would quickly become lost (or kept by players who are hoarders). After examining this option, it was decided to print answers on a single sheet, but to explore ways of designing the cardholder such that manipulation of objects would still be involved when an answer was located. A physical component to the activity is important for aiding learning through other memory systems, in this case procedural memory, and is also a key Montessori principle.

We wanted to determine an optimal number of answers to print on each answer card. This decision would influence design features of the cardholder. Originally, the game had been played with 6 answer cards per game (one answer on each card). Activities staff requested that we increase the number of answers per game increasing the playing time of each game, but to still have a small enough number of answers so that closure could be reached (i.e., most participants would be able to find all the answers) within a reasonable time frame. After trying different numbers of answers per game, we settled on either 8 or 9 answers per game as a number that would enable the activity to be completed within 30 minutes.

We also determined that using 9 answers on each answer card in a 3 x 3 array was optimal in terms of insuring that each item could be read and reached by older participants. A 2 x 4 array presented difficulties in that the items at the top of each of the 2 columns of an array were sometimes difficult to read or reach for older participants, while a 4 x 2 array was too wide to accommodate a 15 inch width (see above) needed for the card holder, given the size of type and length of words we wished to use. In addition, the 3 x 3 array gave us an extra answer per game compared to a 4 x 2 array.

One way to expand the time of a particular game is to provide probe questions regarding answers so that a game leader can enable players to reminisce

about the topic depicted in a particular answer. For example, if an activity card read, “I’m singing in the…” and the answer was RAIN, then we suggest the game leader ask questions about this musical and song title. This information, from a popular movie, is from long-term memory from the era when the person was young. So this type of information is likely to be recalled with multiple cues, and be of interest and trigger other associations leading to engaging discussion. The leader asks participants to sing the song, tell who was in the musical and ask people to reminisce about whether they enjoy the rain or not. We find that this multiple-level cueing allowed both higher and lower functioning individuals to participate, and be engaged.

Thus, two games could be played over the course of an hour. Thirty minutes and 1 hour represent typical type segments allocated to activities for persons with dementia. In long-term care, 30 minutes is more typical, while in adult day care and assisted living, one hour is more the norm.

The development of extra questions can also help bridge the gap when people of varying Mini-Mental Status Exam's (MMSE) are playing together. A person with a low level of dementia may want a stronger challenge and would enjoy being able to answer “trivia” questions. On the other hand, residents with advanced dementia are able to tap some long-term memories and remember a song that they learned years ago. This allows a more successful blending of groups composed of varying abilities.

Last, we found through the interjection of extra questions throughout our games, it helped to decrease the competition that can sometimes arise in other games. Extra questions helped participants to focus more on the individual items and not look at winning as the only objective of the game.

We wanted to have a print size that would allow most older adults with dementia to be able to read answers at a distance of about 16 inches, and that would be small enough to allow an optimal number of items to be printed on each sheet.

We decided that a 1” X 4” opening for each answer item was the best in order to fit 9 items on a game board. This limited our font size and we began to experiment with 40 pt. size, Arial, bolded text (using Arial bold font to accommodate for changes in vision associated with both aging and dementia, as described above) as the largest that could fit within each opening and still allow items with a sufficient number of letters. This is the font size that we tested with all of our recruits. If they were unable to read this size font, they were excluded from the study. For this, we asked participants to read 9 words of varying length. Of 46 recruited participants for this test across adult day care, assisted living, and long-term care sites, 41 of them or 89% were able to read some or all of the words in this size and style of print.

III. Study 1

After determining initial design parameters for the activity, we were still confronted with selecting from a number of options in two key areas: Design of the Card holder and Manipulation of Answer Items.

A. Design of the Card holder

We wished to select from among four specific features for the card holder: 1) Use of a tiered versus flat surface; and 2) Use of a device to provide an angle for the card holder surface by using a fold-up arm, a wedge design, or a contoured device for the legs.

B. Manipulation of the Answers

Four different methods of providing manipulation of answer items were examined:

1. Using a translucent window shade to cover an answer sliding from left to right.
2. Using a translucent window that flipped up or down on a hinge to cover an answer.
3. Using a translucent window shade to cover an answer sliding from top to bottom.
4. Using detachable pieces to cover each answer that was called in a game.

IV. Study 1 Method

Four different types of mock-ups were developed to allow us to test these specific design features. Our procedure for pilot testing design features consisted of showing mock-ups to activities staff for initial comments and feedback. Then we presented these materials to persons with dementia and focused on the ease with which they were able to read answer items and cover them. We measured the amount of time it took for these participants to read and cover answer items for all mock-ups. We also interviewed these participants to obtain their opinions regarding answer items’ content, satisfaction with and opinions about the cardholder and answer covering mechanisms, etc. Twenty older adults with dementia from adult day care, assisted living, and long-term care units of a well-known Cleveland, Ohio Senior Living Facility took part in this pilot work for each mock-up, in addition to four activities staff.

We did six different comparisons of the four types of mock-ups. We asked participants to test the ease of use of each of the mock-ups, to judge the base of the units, and to tell their opinions about which mock-up they favoured. When able, participants expounded on why they liked or did not like each mock-up. In addition, we used stopwatches

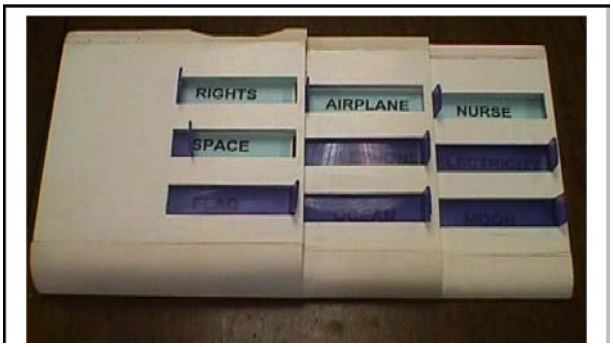

Fig. 3. The Mock-up features tiered cards, a fixed wedge design, and left to right sliding windows. The tiered cards were awkward to insert compared to flat cards. The tiered design made it hard for the leader to monitor and the boards difficult to store. The board was also too wide for a wheel chair. This design had many disadvantages.

to time how long it took participants to cover and uncover the words in the mock-ups.

For each comparison, participants were asked to read the words on the cards of each mock-up. They were asked to read the first column, and then the second and third columns. Researchers demonstrated the covering of a word. Participants were then instructed to cover the words in order, column by column. Then, participants were introduced to the second mock-up. Again, they were shown how to cover a word. They then were told to cover all of the words on the board in order, column by column. Each trial was timed. Participants were then asked to judge which board they thought was easier to cover the use. They were also asked which motion they preferred. For example, participants comparing the top to bottom sliding mock-up to the left to right sliding mock-up, were asked to tell if the sweeping up motion of the wrist to cover the words on the top to bottom mock-up was easier than the back and forth motion required to cover the words for the left to right sliding mock-up.

Participants were then asked to read the words with the translucent covers over them. Researchers demonstrated to participants how to uncover words on the first board. In turn, participants were instructed to uncover the words in order, column by column. This procedure was repeated with the second mock-up. Each trial was timed. Furthermore, the participant was asked to confer which motion was easier to use and which was preferable when uncovering the words on the board.

Then, if there was a structural difference in the design, such as a flat base compared to a contoured base, we asked participants to tell which base they liked better and why. Furthermore, if there was a difference in the covering system, we asked them to tell which they liked better and why.

Figure 3 shows a mock-up of a tiered game holder with left to right sliding shades to cover answers. This mock-up used a fixed wedge system on the bottom of the card holder to provide an elevated angle for the playing surface of the card holder. The tiered holder was necessary to accommodate a left to right sliding shade.

Figure 4 shows a mock-up with a flat playing surface using hinged windows to cover answer items. The design also included the use of a fixed tilt device contoured to a player's legs, such that it could fit comfortably on a lap without producing a large amount of angle to the surface of the cardholder.

In addition, note that the answer card has black lettering on a white surface to provide maximum contrast between printed letters and background.

The third mock-up, depicted in Figure 5, featured an adjustable tilt device on the bottom of the card holder that could be pulled out to set the playing surface at an angle or that could lie flat in a recess on the bottom of the card holder to allow a flat playing surface. Covering the answers was achieved by sliding a shade from top to bottom.

A fourth mock-up, depicted in Figure 6, represented a very different approach. The board contained a compartment where round plastic ovals with handles were stored. The oval pieces are used to cover the answers. Testing indicated that participants had difficulty gripping the pieces and inserting them into the board. Players wanted to place the pieces in the holding area in a precise pattern and were distracted by the pieces during the activity. Pieces

Fig. 4. The Mock-up features a hinged-shade, color-coded answer cards, and a leg-contouring tilting system (not shown). The leg-contour tilting system was comfortable and desirable for persons in wheel chairs. The hinged shade blocked the view of answers when in the open position. Color was a distraction to participants.

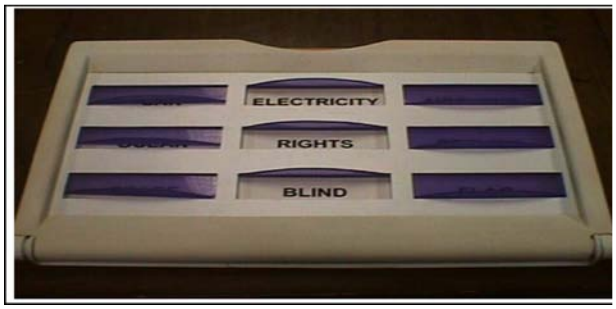

Fig. 5. The Mock-up features an adjustable tilt device with hinges visible at the front and top to bottom sliding windows. The tilting mechanism is flat and not contoured to a persons lap. The top to bottom shades were easy for players to learn, required minimal effort, and were found to be the optimal covering system.

were likely to be targets of hoarding and easily lost.

V. Study 1 Results

It was determined that the leg-contoured tilting system was a desirable feature, in that it did not produce an inordinate amount of angle and could accommodate persons in wheelchairs well when a table was not available. However, given that some players preferred to use a table when taking part in the activity, it would be desirable to make this tilt feature optional by making it detachable.

With regard to the use of a top to bottom sliding window to cover answers, players found this approach easy to learn. In addition, the large area of the tab available with this approach made it possible to cover answers with minimal effort (a single finger could slide the shade). It was decided that this was the optimal feature for covering answers in situations where the covering system was a fixed part of the cardholder.

While many players could accomplish the use of detachable pieces to cover answers, we encountered some difficulties using this approach during the course of the activities. Some had more difficulty gripping and inserting these pieces than simply sliding windows as a means of covering answers. Problems with losing covering pieces, both in terms of persons with dementia who engage in hoarding and in terms of general problems losing lose pieces contributed to a decision to abandon this method of covering answers.

As a result of this pilot-testing phase, we determined the features that we wanted to have on prototypes for Study 2. These included:

- A leg-contoured, detachable element to allow players the option of tilting the playing surface.
- Using a flat rather than tiered playing surface.
- Using a top to bottom sliding window system for covering answers.
- Development of probe questions for game leaders to extend the time of playing each game.

VI. Study 2 Prototype Testing

As a result of the pilot–testing phase of the study, a prototype design for the game incorporating the features just described was developed. Ultimately, 15 copies of the prototype were developed. A photo depicting the prototype of Memory Magic™ Program utilized in Study 2 is shown in Figure 7.

A. Determination of Primary Outcome Measure

We wished to develop an outcome measure that would focus on aspects of participation in activities that were relevant to activities professionals and that would link to concepts important to researchers in dementia care as well. Therefore, the focus of the instrument involved whether persons with dementia refused to take part in activities, engaged in activities, and demonstrated various types of affect during activities. The outcome measure – The Menorah Park Engagement Scale (MPES) involves direct observation of participants while taking part in Memory Magic™ (Treatment) and in other regularly scheduled activities (Control).

Two research assistants were trained to take observations during both the treatment activity and control activities. The two observers became reliable on all 12 items on the form. They had .85 agreement or better on all 12 items across 27 observation sessions. The key issue to be resolved was whether the instrument would prove sensitive to the effects of the intervention (the Memory Magic™ Program).

B. Results

Data were gathered from 24 participants over the course of two months. Of these 24 participants with dementia, 10 were in long-term care, 9 in adult day care, and 5 in assisted living. Averages of demographics of these groups are shown in Table 1.

Age was not statistically different among groups, but MMSE scores did reach significance, with each group being significantly different from the other (utilizing a one-way ANOVA and post-hoc testing).

Table 1—Participant Demographics

	N	Age (Yrs.)	MMSE
Long Term Care	10	88	11
Adult Day Care	9	80	17
Assisted Living	5	88	20

We initially analyzed data using a 3 (Setting – Adult Day Care, Assisted Living, and Long Term care) x 2 (Treatment Condition – Memory Magic™ Program vs. regular activities programming) x 2

Fig. 7. The prototype features a detachable contoured tilt device, a flat surface, and top to bottom sliding windows. The game cards are inserted through a slot at the top. A total of 15 prototypes were constructed to facilitate a test of the group therapy

(Month of Testing – First vs. Second Month) mixed model ANOVA. Examining the Month of Testing Effects, we found no significant main effects or interactions for any MPES item examined with one exception.

With regard to "Offered Help to Other Players," a significant effect was obtained for the Treatment Condition x Month of Testing interaction, $F(1,14) = 7.67$, $p < .015$. Means (and standard deviations) for the First Month for this item were 1.3 (.09) and 1.1 (.05) for the control and treatment conditions, respectively. Means (and standard deviations) for the Second Month for this item were 1.0 (.03) and 1.2 (.08) for the control and treatment conditions, respectively. Thus, helping behaviour decreased over time in the control condition and increased slightly for players of Memory Magic™ Program. As a result, we have excluded the Month of Testing factor from the rest of the analyses reported.

In these analyses, all observations taken in treatment and control conditions have been averaged for each participant to provide a single treatment (Memory Magic™ Program) and control (regular programming) score. Initially, we analyzed MPES items using a 3 (Setting – Long Term Care, Adult Day Care, Assisted Living) x 2 (Treatment condition - Memory Magic™ versus regular activities programming) ANOVA. We were primarily interested in whether setting influenced outcomes in this first set of analyses. Main effects for Setting and/or for the Setting x Treatment interaction were found for three MPES items – Did the Activity (Constructive Engagement), Slept During the Activity, and Offered Help to Other Players. Means associated with these effects are shown in Table 2.

Table 2—Means Associated with Main Effects for Three MPES Items

	Treatment	Control
	Did the Activity	
Long Term Care	2.4	1.8
Adult Day Care	2.7	2.2
Assisted Living	2.8	2.1
	Slept	
Long Term Care	1.2	1.8
Adult Day Care	1.0	1.5
Assisted Living	1.1	1.0
	Helped	
Long Term Care	1.1	1.1
Adult Day Care	1.6	1.1
Assisted Living	1.4	1.5

For “Did the Activity,” significant Setting effects were found, $F(2,21) = 5.0$, $p < .02$, with players in long-term care showing less time engaged in activities than in the other settings. For “Slept,” a significant interaction between Setting and Treatment was found, $F(2,21) = 3.6$, $p < .04$. Players almost never slept during the treatment activity, but persons in long-term care and adult day care slept during control activities. For “Offered Help to Other Players,” a significant effect for Setting, $F(2,21) = 4.0$, $p < .03$, and for the Setting x Treatment interaction, $F(2,21) = 7.0$, $p < .005$, was found.

Helping almost never occurred in long-term care (we worked on units with more advanced dementia. However, in a pilot study depicted in Appendix B, we observed helping behaviours on a special care unit for dementia among residents with early stage dementia). Helping behaviour was seen among adult day care participants, but only during Memory Magic™. In assisted living, helping behaviours were seen in both types of activities.

Our major interest was in whether participants playing Memory Magic™ would be significantly different on key items of the MPES than when these same participants were taking part in regular activities programming. Collapsing across groups and examining overall performance, we first examined differences in these treatment conditions on agreeing to come to activities. We found that for regular programming, only 8% of participants agreed to come and take part with an indication that they wanted to be in the activity across all observations. For Memory Magic™, 79% of participants indicated that they wanted to take part in the activity across all observations. Thus, Memory Magic™ appears to be a game that requires little persuasion in order to get persons with dementia to come to take part.

Table 3—Average Performance in Regular Programming vs. Memory Magic™ Program

	Regular Programming		Memory Magic™		
MPES Item	**Mean**	**Std. Dev.**	**Mean**		**Std. Dev.**
Constructive Engagement	2.04	.424	2.58	***	.346
Actions External to Activity	1.54	.380	1.19	***	.300
Alert and Listening	2.36	.340	2.38		.346
Showed Pleasure	1.50	.384	1.92	***	.250
Showed Anxiety/Sadness	1.34	.429	1.10	*	.221
Slept/Kept Eyes Closed	1.52	.557	1.10	***	.294
Helped Others	1.17	.294	1.32	*	.397
Inappropriate Behaviors	1.17	.269	1.10	*	.201

* p<.05

***p<.001

Table 3 shows average performance in both control (regular activities programming) and treatment (Memory Magic™) conditions. Again, the scale used was: 1) not at all; 2) up to 1/2 of the activity; 3) 1/2 to all of the activity, with regard to observation of the target construct during a 30 minutes observation period.

VII. Conclusion

The prototype version of Memory Magic™ elicited both higher quality and amount of engagement than standard programming, produced more positive and less negative affect, and was related to a reduction of inappropriate behaviours compared to levels seen in regular programming. All outcomes are in the directions hypothesized. These results also indicate that the MPES appears to have adequate sensitivity to detect the effects of Memory Magic™ Program in these settings.

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