A Study on Design for Diagnostic Tool for Language Processing Ability with Aging - Focused on 'Verb naming'

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Abstract

The deterioration of linguistic abilities is a natural phenomenon along with aging. Therefore, various assessment tools have been developed to measure linguistic abilities of seniors and diagnose degenerative diseases such as dementia. Although most of the tools are composed of images, there are not many studies focusing on the visual design, which could significantly affect performance of the subject. In this regard, this research aims to suggest a design guideline for linguistic ability assessment tools concerning the key characteristics of the elderly, focusing on visual contents and interface.

Existing related researches were mostly conducted in English-speaking countries. In order to assess the language processing abilities of Korean-speaking elders more accurately, it is necessary to develop language processing assessment tools that reflect the unique linguistic features and structure of the Korean language. Regarding the existing tools, there is a lack of research on aging, focusing on 'verb naming.

In the literature review section, the paper investigated the physical, cognitive and emotional characteristics of the elderly and extracted the key elements to consider when designing for the elderly. Also, design principles were found based on case studies and problem analysis of the existing assessment tools for language processing abilities. Lastly, we created a prototype model using 'verb naming.' Using the model, we have conducted an experiment and comparative analysis between different age groups to verify the validity of contents.

In conclusion, we provided a design guideline for visual contents and interface of linguistic assessment tools, focusing on elderly users.

Keywords : Elderly Adults, Language Processing, Assessment Design Guideline, Interface Design, Animation Contents, Elderly Design

Introduction

Various research on the decline of language processing ability along with aging has been conducted, mostly in English speaking countries(Caplan, DeDe, Waters, Michaud, & Tripodis, 2011; Waters & Caplan, 2001; 2005). Assessment tools for language impairment that can diagnose the early progression of degenerative diseases such as dementia have been developed. However, despite the fact that most of the diagnostic tools are composed of image contents,

there is a lack of research on visualization design of contents, which can affect performance. In addition, most of the researches related to degradation of language processing ability are conducted in English. Therefore, to accurately examine the declining of language processing ability among Korean users, it is necessary to develop a language processing task that reflects the characteristic structure of the Korean language.

Currently, most of the diagnostic tools for diagnosing language processing abilities are focused on the 'Noun naming' research, and there is limited research on 'verb naming' related to aging. Jee Eun Sung, Eun Jung Kwag(2012) produced an animation consisting of 8 frames of black and white lines, and used it as a naming task for the verb. According to this study, the verbal naming ability of different age groups is differentiated by the argument structure. However, there is no study on the correlation of cognitive abilities perceived by the elderly.

The purpose of this study is to suggest guidelines for contents and interface design of language ability diagnostic tool while considering characteristics of the elderly. Among them, we would like to present an optimal visual contents style focusing on the task of 'naming the verb'.

Research Methods

In this study, first, literature review was carried out through previous studies related to the biological and cognitive characteristics of the elderly and research on theoretical data. In addition, we examined research on the language ability diagnostic tools currently in use.
Based on the collected language diagnostic tools, we analyzed the elements that should be considered in the design aspect, suggested the first interface design guideline, and made a prototype of the 'Verb naming' diagnostic tool in line with the principles
We carried out the user test among 32 participants, 16 in the younger age group (aged 20 ~ 39) and 16 in the elder age group (age 65 ~). Tests were presented on a portable computer in a one
- to - one situation, and prototypes of four stimulus types for each verb were presented in random order for each subject. Based on the experimental results, we revised the interface design guideline for language ability diagnostic tool considering the characteristics of the elderly.

Literature Review

1. Biological and Cognitive Characteristics of the Elderly
This study classified elderly people over 65 years old based on labor law standards. Elderly people undergo a lot of changes in terms of biological and cognitive aspects. Hong Suk-jae (2010) suggests that aging reduces sensory experience by slowing sensory organs, which reduces opportunities for external recognition and makes communication difficult. According to Jin Hee Chun(2003), along with aging, the ability to perceive saturation weakens. Therefore, the elderly perceive orange as red or purple, green as blue, and blue as indigo, while purple is perceived as purple without discoloration. Also, dark colors such as brown seem to be closer to black, and they may not perceive the small differences in brightness. In order to increase visibility and discrimination, Arthur,P., Passini, R.(1992) stated that the difference in brightness between figures and background should be clarified when considering older people. In addition, older people have difficulty adapting to sudden light changes and are vulnerable to light reflections, so light brightness is an important visual consideration when content is embedded in digital devices.

1.1. Design Elements Influenced by Changes in Biotic Sensory Function

We have identified the main design elements as line, shape, color and layout. When using the line, it is necessary to avoid the use of thin lines, which is difficult to perceive for the elderly. You should use simple shape and refrain from using patterns in shapes. Elderly people need clear guidelines for color usage because they are less able to respond to changes in color brightness and saturation. It is recommended to use colors such as red and orange in the long wavelength series, and they should be used properly considering the meaning and purpose of each color. It is also good to avoid using blue for important features as there could be yellowing of the blue color among the elderly. The arrangements and layout should be simplified and easy to understand. It is better to use a simple, iterative layout rather than a complex and diverse layout. Leave margins as much as possible, and do not stack elements together.

1.2. Interface Components Affected by Cognitive Characteristics

Interface components influenced by cognitive characteristics of older people are defined by type of contents, and interface. For type of contents, as elderly people have difficulty in recognizing temporal resolution stimuli, it is better to prohibit the use of moving images. If you use animation or video clips, it is better to use it repeatedly. When designing interfaces for elderly people, users should be allowed to control the size of the contents themselves. It is recommended to provide a touch interface method rather than a mouse operation method.

2. Current status of Diagnostic Tool for Language Processing Ability

2.1. Visual Problems of Currently Available Language Processing Diagnostic Tools

The design elements and the interface components were analyzed for three main language ability diagnostic tools (Figure 1,2,3) currently in use.

Figure 1: Understanding & Discriminative Noun Test for Language Therapy (Hu&Yu Hospital)

Figure 2: Daegu Aphasia Diagnosis Assessment Tool (Jung, Ok-Ran)

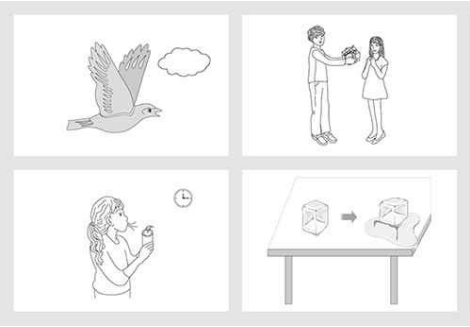

Figure3: Verb Naming Diagnostic Tool(Neurogenic communication and Brain Lab at Ewha)

We have analyzed the visual contents problems of the existing language processing diagnostic tools. The results are as follows:

a. Unconstrained visual complexity: In the case of overly complicated visual contents, the visibility of the core information is degraded, and if it is too simple, the concentration may be reduced.
b. Inconsistent expression methods: Presenting different styles of contents within the same task can give users a visual fatigue.
c. Using overly infantile forms: The use of overly infantile forms or the use of sophisticated styles tailored for young users lowers objectivity and reliability as a diagnostic tool for the elderly.

Discussion

1. Prototyping

1.1. 'Naming Task for the Verb' Content
First, visual contents showing certain movements or actions are presented to the participant, and then the participant describes the movements or actions with their own verbal expressions. The Korean 'naming the verb' task used in this study consists of 4 types, in total 24 verbs, composed by Su Jin Choi, Jee Run Sung (2014). For prototyping, verbs of each categorywere selected based on frequency of use and representativeness. Among them, four verbs were selected - fly, melt, blow / turn off, and give(Table 1).

Table 1. Verb naming words & selected words

Verb Type	Section 1-unergatives	Section 1-unaccuasatives	Section 2	Section 3
Target Verb	fly	boil	press down	plant cry
		Melt	tie	insert
	run	Dry	take off	follow
	sleep	Wilt	open	throw
	sit	take off	blow/ turn off	load
	bark	Blossom	hew	give

1.2. Media and Contents Representation
According to Sunyee, Park., Hochun, Choi. (2011), illustrations can be classified into realistic illustration, abstract illustration, hemispheric illustration, characters and symbolic illustration, and surreal illustration. In this study, we chose realistic line illustrations for the elderly with

low cognitive abilities.

1.3. Prototype Type

The prototype of each representative verb is composed of four components: cut image, sequence image, normal speed animation, and slow speed animation (normal-speed of 120). It is made in achromatic color with a high brightness contrast for the old age group with low color perception. We used the universal and realistic form, and reduced decorative features. Also, we used simple layouts and generous margins. Reflected light is applied to the whole background in consideration of the elderly who have difficulty adapting to light reflection(Figure 4).

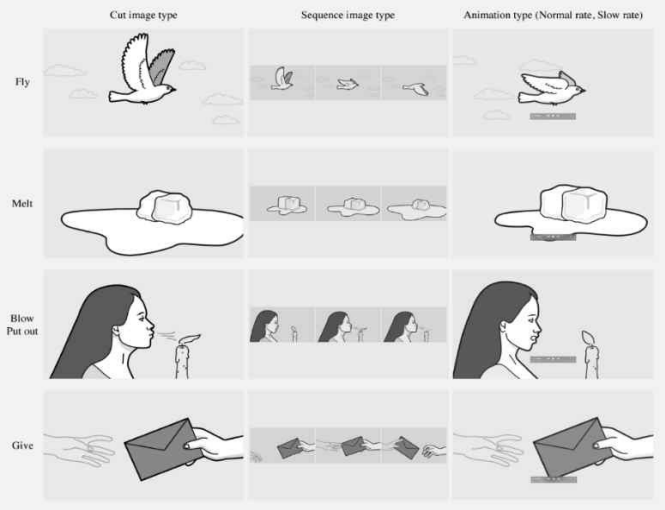

Figure 4: Prototype

2. User test design

2.1 Subject

This study was conducted for 16 young people aged 20 ~ 39 and 16 elderly people aged 65 or older only as a control group for comparison of results.

2.2 User test procedure

Before proceeding with this test, we provided detailed instructions and made them practice to make sure that the subjects understood the contents accurately. Prototypes of the four stimulus for each verb were presented in random order to each subject. Each subject took two tests and the subjects were given enough time between the first and second so that the first test did not affect the second test.

2.3 Test rule

For each question, 1 point is given for correct response and 0 point for false response. The subjects were provided with a maximum of 15 seconds per question and if no response is given within 15 seconds, or if the subject requests to repeat the instructions, an additional 15 seconds are provided after repeating the instructions again.

A total of two repetitions per question is allowed and if the subject does not respond after the second instruction repetition, it is treated as a false response.

2.4 Analyze test results

The user test was analyzed by two factors (performance and cognitive time). The results are as follows.

Performance: Correct reaction, false reaction (1 point for correct reaction, 0 point for false reaction).
Cognitive Duration Time: The time measured until the target verb was spoken.

Table 2. Inter-group performance results

	Cut Image	Sequence Image	Normal speed Animation	Slow speed Animation
Old	0.78125	0.90625	0.8125	0.875
Young	0.875	0.875	0.9375	0.96875

Table 3. Time spent between groups (unit: second)

	Cut Image	Sequence Image	Normal speed Animation	Slow speed Animation
Old	5.71875	6.34375	4.53125	3.84375
Young	1.40625	1.375	1.28125	1.65625

In the case of performance (correct or false response), there was no significant difference between the two groups for all four types of stimuli (Table 2). However, in the case of response time, young people responded within 2 seconds in average for all types of stimuli but the average response time for the elderly were significantly longer than the young. The minimum time was 3.84 seconds for slow speed animation, and the maximum time was 6.34 seconds for sequence image(Table 2). In average, the elder responded faster when the stimuli was in animation than in images, and it took the longest to respond when presented with sequence image.

Therefore, based on literature review and test results of the prototypes above, we suggest the following guidelines for contents and interface design.

Table 4. Summary of guidelines for contents and interface design of language ability diagnostic tools

Elements	Contents
Style	Within the same task, styles should be expressed in unity. To control the complexity of the target vocabulary (noun, verb, etc.), we Recommend realistic illustration styles rather than live shots. Encourage line drawing styles. Avoid overly distinctive styles and use a universal style to clarify information delivery.

Complexity	The visual complexity must be lowered by excluding the ornamental Elements other than objects expressing the target vocabulary Only when the object expressing the target vocabulary is too simple, it is Allowed to describe the surrounding elements for the purpose of matching the visual complexity with other contents.
Form	Use the universal and realistic form, but reduce any ornamental depiction.
Color	Use a color scheme with a high contrast of lightness, saturation, and color.
Line	Avoid using thin line for high visibility and use thick line
Layout	The size of the object or person expressing the target vocabulary should be more than 40% of the screen. Use a simple layout and a generous margin Avoid showing elements in layers.
Brightness	When using electronic media, avoid using a large area of white (# 000000) and apply light gray.
Motion Speed	In the case of animation, approximately 120% duration is applied than the normal speed.

Conclusion

In this study, we first examined the physical and cognitive characteristics of the elderly, and then analyzed the problems of the 'naming task for the verb' which is one of the existing diagnostic tools of language ability, and presented contents and interface design guidelines for language assessment tools focusing on characteristics of the elderly.

Based on these design principles, we created prototypes and conducted user tests among two different age groups to revise the design guidelines suggested in this research.
The results show that the average performance rate of ‘naming task for verb’ between two groups were not significant between the two groups. However, there was a significant difference in the response time between the two groups for all four stimulation types. Moreover, for the elderly, the speed of cognitive recognition was fastest when presented the stimulation was presented in the slow speed animation form. This suggests that the speed of animation can affect the speed of cognitive response among the elderly.

This study has clinical significance in that it presents basic guidelines for future research on contents and interface design for language ability diagnostic tools. However, there are some limitations and avenues for future research. First, we have only tested 4 verb types among 24. Second, the number of participants (32 in total) for the testing seem to be relatively small. Third, we divided the age group into two groups, but it could be divided into shorter age-span groups to analyze differences in performance and response time along with aging, in the future.

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