

# A STUDY OF CONSIDERATIONS TO THE DESIGN CRITERIA FOR PARKINSON'S DISEASE TOYS

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## ABSTRACT

Parkinson's Disease (PD) is considered to be a common disease globally, being diagnosed in elderlies regardless of hereditary and or environmental factors. Though gadgets are more widely utilised to aid PD patients, toys can provide a more enjoyable, educational and or interactive approach in improving their user's everyday lifestyle. The current market for PD is relatively limited and can quickly bore the users physically and mentally. Hence this paper aims to recognise and propose a set of considerations to the design criteria for Parkinson's Disease toys, as well as put forth a conceptual product that encompasses and analyses the findings.

*Keywords: Parkinson's disease, toy, design criteria, suggestion, design research*

## 1 INTRODUCTION

There are three major points in designing a toy for Parkinson's Disease: Firstly, it is globally the second most common neurodegenerative disease, whilst locally affecting approximately 4% of Hong Kong (HK) elderlies aged 80+ [1]. Given the nature of this disease, there is no permanent cure once diagnosed; only the prevention and extending the progression of worsening symptoms. Although many do suggest that Parkinson's is partially a hereditary disease, it is also argued that environmental factors are one of the major contributors to activating Parkinson's, implying everyone will have relatively equal chances of being diagnosed in senior years. Second, given that aging is inevitable, designing for elderlies will benefit both current and future societies. Lastly, toy products have the potential to be multi-issue solutions - being both educational and enjoyable - therefore being a relevant PD symptom-alleviating tool by being able to potentially maintain and or retrain the cognitive and motor skills lost due to degeneration, whilst improving mentality. Due to the lack of specialized toys for PD, this paper aims to highlight considerations to the design criteria for Parkinson's Disease toys through research and user feedback on physical prototypes.

### 1.1 Understanding Parkinson's Disease

Understanding the issue will be crucial to devising the considerations to the design criteria. In short, Parkinson's Disease (Parkinson's or PD for short) refers to the loss of functionality in the Substantia Nigra region of the brain; the main producer of dopamine - of which affects motor control and mood [2]. The degeneration of abilities is exponential and are commonly rated with the Hoehn and Yahr scale (of which has often been criticised for only gauging movement impairment progression, thus neglecting mental instability).

## 2 RESEARCH METHODOLOGY

Research can be split into 2 main categories: User research that covered a questionnaire, interviews and additional secondary research, and conceptual prototype feedback. User research was used to formulate the design criteria, whilst the prototype feedback allowed confirmation on the effectiveness of said criteria. In further detail, the questionnaire focuses on the relationships between youthful participants aging 15 to 25, and their grandparents to have a general understanding of inter-generational relationships specifically in HK. The interviews were not consisted of formulated questions, but rather freely discussed, focusing on the PD patient's family members and helpers (if applicable) to get insight on first-hand experience with taking care of the PD patient. Lastly the secondary research consists of brief findings to partially compensate for the low quantitative primary data.

Prototyping feedback will be done with one neighbouring family taking care of an elderly with PD. This is mainly due to the current pandemic worsening locally, discouraging face-to-face contact; hence data collection will be following the style of designing for one user, before adapting for more. Note that said participant is stage 5 PD, therefore the prototype feedback will be from the extreme spectrum.

### 3 RESULTS AND DISCUSSIONS

#### 3.1 Questionnaire

A total of 84 participant responses were recorded within a one-month period. The results show that approximately 90% of participants lived in separate residences from their grandparents and would visit them between long periods of time. This is due to the participant’s lack of time and quality of communication. For confirmation, the 2017 HK Family Survey [3] has also stated that an estimated 85% of HK families did not live with the elderly yet maintained good relationships (as was found from the questionnaire). From this, one consideration to be made is that the PD users are living separate from the nuclear family, hence increased attention on allowing the toy to be used independently (includes interactive dexterity and mobility).

#### 3.2 Interview

Short interviews which lasted approximately 20 - 30 minutes were conducted during questionnaire response collection, and can be summarised as shown in Figure 1:

Family A <i>Diagnosed period: ~3 years. Current</i>	Family B <i>Diagnosed period: ~5 Years, [Passed]</i>	Family C <i>Diagnosed period: ~10 years. Current</i>
<ul style="list-style-type: none"> <li>- Large family living together with grandparents</li> <li>- Condition worsened exponentially during past year</li> <li>- Recently hired a part time helper to tend to their needs</li> <li>- Practice stretching exercises every morning and afternoon</li> <li>- Positive attitude to keep hopes up</li> <li>- Daily interactions in late afternoon: games, snacks and tea</li> <li>- Difficulty in constantly motivating affected family member (AFM) into</li> </ul>	<ul style="list-style-type: none"> <li>- Meets 2 time year, calls once a month</li> <li>- Hired helper and ate medicine</li> <li>- Loss of movement each time they saw her</li> <li>- After 2 years of diagnosis cannot walk; required to use a wheelchair; was very active prior               <ul style="list-style-type: none"> <li>- Mental degeneration seems to occur after 3rd year diagnosed</li> </ul> </li> <li>- Easy to lose temper, attitude and personality changed a lot</li> <li>- Singing seems to help</li> <li>- AFM did farming as a hobby, raising chickens and vegetables</li> </ul>	<ul style="list-style-type: none"> <li>- Daughter has doctor degree, peers have access to newer methods of re-stimulating muscles</li> <li>- Very open to solutions</li> <li>- AFM participated in electrotherapy</li> <li>- Constant and consistent exercise</li> <li>- Had to begin in early stages (stage 2.5 and beyond is difficult to manage)</li> </ul>

Figure 1. Interviews with families - summarised responses

Through interviews, the necessity for the consideration of mental stability is suggested, most notably with families A and B. Results also suggest that it takes approximately 2 to 3 years after diagnosis for symptoms to worsen until stage 5 unless diligent action has been taken immediately after diagnosis (as implied with family C). One major observation that can be deduced is the PD user’s lack of motivation to maintain their abilities, of which can be a consideration (though secondary, as entertainment is already a primary purpose of toys) - further supported by the user’s rapid decline in positivity; spontaneous pessimism or fits. By comparing the three, we can see that at the later stages of Parkinson’s, familial and friend support plays a vital role in keeping morale - as conveyed in family A’s frequent visits and activities together, family B’s singing to elevate mood, and family C’s encouragement to take action early. When taken into account, this can be a combination of motivation and independence.

#### 3.3 Additional Secondary Research

Medication also becomes a necessity in the daily lifestyle of PD users in late stages, with the tendency to rely on dopamine supplements (Levodopa) or inhibitors that prevent enzymes from breaking down nerve cells to function relatively normally [4]. Its significance is highlighted through the consideration that the toy should be easily picked up and placed down conveniently, not just for meals but also after short bursts as the PD user gets tired. Natural remedies include enhancing wellbeing via exercising, the ability to have quality sleep, frequent exposure to sunlight and dieting [5]. Studies concluded that there was a positive correlation between exercising and levels of dopamine, though the level of effect was not consistent with each participant. Additionally, Tsai et al further confirms that participants who were

frequently exposed to sunlight also produced the highest density of dopamine receptors [6] - though these were based on healthy participants, the studies suggest that outdoor activities are beneficial to PD users and so can be linked to environmental considerations.

Case study wise, Michael J. Fox, of whom has lived with Parkinson's for 30+ years has attributed his ability to cope with PD for such an extended period of time to enforcing positive mentalities. Though he admits pessimistic mentality is inevitable, it was ultimately the support and understanding from his inner social circle and family that enabled him to accept and live with PD [7]. Three product types - PD gadgets, toys and elderly toys / forms of entertainment - were compared in order to better understand the current market, as well as it's areas that can be improved, Figure 2.

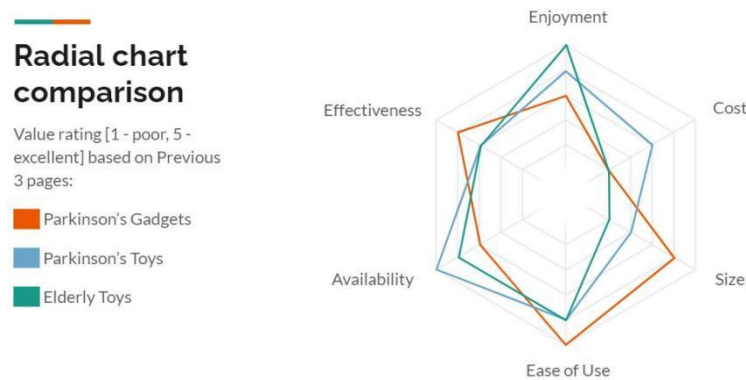


Figure 2. Comparison of current market products

To summarize, the findings indicate that there is limited to no specialized toys for PD; many of which are simplistic in functionality, i.e., weighted blankets and puzzles suitable for developing children are marketed as toys for PD. Relative to section 3.2, family A bought and tested a variety of said PD toys yet found that these solutions were unsuccessful in the long term (given the user lost interest after several months). In terms of training or ability maintenance, gadgets are solely used to counteract physical symptoms such as tremors, although it is arguable that this in turn reduces the negative mentality by dampening frustrations from low dexterity. Elderly toys were also analysed as a reference to what the PD users used play pre-diagnosis, which could affect the usability and acceptability of new toy concepts. Locally, this refers to games such as mah-jong or Chinese chess, of which requires both finger dexterity and cognitive processes (hence the inability to play can be an incentive to use a specialized PD toy).

#### 4 DESIGN CRITERIA, CONCEPTS AND FEEDBACK

In response to the findings and considerations noted, there are several routes in which a product can follow when being designed for Parkinson's disease:

- A toy that focuses on training mental capabilities and motor skills, similar functionality to puzzles.
- Improving the target user's standard of life; making a social toy that makes them feel "normal" when by themselves and with others.
- Focusing on ensuring or cultivating an optimistic mindset; a toy that counteracts or reduces mental instability
- A product that enables increased quality time between the nuclear family and the grandparents, PD patients

Note that it is crucial to differentiate a toy from a gadget: A toy should first and foremost be used for active entertainment rather than passive interactions.

##### 4.1 Initial Criteria and Considerations

Given the time restraints to produce and test the concepts, the criteria and considerations are updated throughout the conceptual stage, rather than being fixed in the beginning. Simplified criteria can be referred to below:

1. User - Designed for extreme spectrum of elderly (assume reduced capabilities such as strength or range of movement); currently for one PD user.
2. Function - Be able to train or maintain the user's skills and abilities, whilst being able to encourage a positive mentality for extended periods of time (independent use).

3. Size - Portable, medium sized (compensate for low dexterity and reduced strength); easily accessible for independent users in sitting and standing positions.
4. Aesthetics - Simple shapes (suitable for holding and grabbing), sharper colours and textures (visual identification, subjective to user preference), recognizable forms (either for nostalgic value or ease of acceptance and continued use).
5. Environmental - Primarily indoors use, able to be used or brought outdoors (reliant on functionality), placed on user or elevated surfaces (tabletops, chairs etc.).

Note that the costs and manufacturing criteria are negligible, as this project aims to find the effectiveness of proposed criteria and consideration, rather than its commercial value. Current criteria can be comparable to designing for elderlies with considerations of reduced capabilities, however level of simplicity should be subtle to allow ease of use without negatively lowering their self-assessment of competency (i.e., reduce the chances of frustration due to feeling they are unable to do anything “normally” anymore; avoid potential stigmatization of capabilities).

## 4.2 Initial Concept

Two main concepts were formulated, the first being a 3D, multi layered puzzle that is designed for independent play called the Matryoshka Puzzle, whilst the second being an interactive electronic plush with digital interfaces aiming to make messaging more enjoyable (Figure 3). After consulting with the target user and their family, the latter concept was preferred and thus continued.

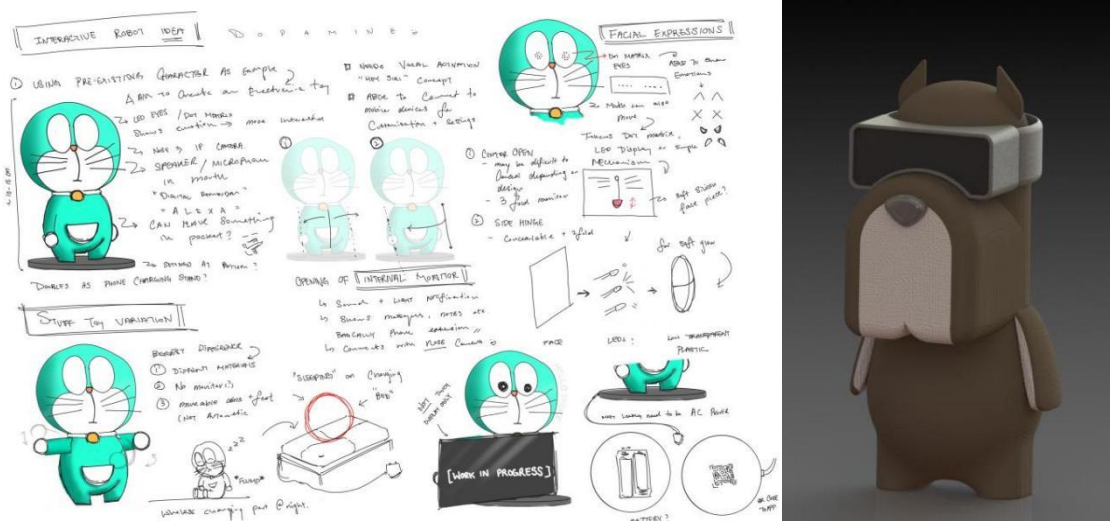


Figure 3. Electronic plush concept

Gordon (rendering on the right) is a portable toy that the user can keep on them through multiple environments. It is approximately 15cm tall and 8cm wide. The initial concept uses well known cartoon characters (in this case Doraemon) as the external form for easier recognition and gimmick value, however due to legal reasons will only be used as an example to explain the features. The body and outer layer of the head will be made of soft materials (e.g., fabrics or elastic plastics) for comfortability and easier gripping. Its secondary purpose is to partially protect the internal components inside an endoskeletal structure (of which also allows the toy to sit on its own when placed on surfaces). Early concepts for this include a built-in screen for easier text visibility, in a way similar to an enlarged kindle, although this was removed in later development due to it over complicating the functionality.

There is a total of 4 main features for this concept: 1. Interface Goggles to display messages, information or different eyes that react accordingly to different user inputs. 2. Microphone and speaker components for direct communication between the users and Gordon. 3. The ability to connect with the user’s phone via Bluetooth or NFC connections and 4. A mini projector built into the nose to display images or screens onto wider surfaces such as walls and ceilings. Features 2 and 4 will be placed in the mouth or body portion of the toy, of which will be decided after the first few prototypes. It is also possible for Gordon have customisable heads - i.e., different types of animals - and possible accessories for personal preferences. By theory, this would be categorized as a specialized PD toy, given the educational aspect

from the functionality combined with entertainment from form, whilst having an appropriate level of maturity.

### 4.3 Initial Prototyping and Brief User Feedback

Majorly due to time restraints, a dimensional prototype (Figure 4.) was made and given to the target user for feedback. This was done by leaving Gordon with said user for a day (10am to 5pm) and collecting their thoughts. In addition, the user's caretaker was also asked to observe the user's mood throughout the day and how they would interact with Gordon. Overall, the user had a very good first impression of Gordon, specifically how the shape and overall cartoon style look made it very appealing. Several areas for improvements pointed out included how the overall dimensions felt smaller than expected, leading to occasional fumbling when handling Gordon. From the caretaker's perspective, the user had a positive attitude throughout the day and held on to Gordon frequently. Besides concerns similar to the user's feedback, they also suggested for the goggle size to be larger when the interface was included, as they stated the user would hold Gordon close to their face when looking at the goggle and face.



Figure 4. Dimensional prototype

Criteria 3 (size) and 1 (user) will need to specifically include considerations for both physical and digital interface dimensions, given that the original concept of smaller dimensions requires less dexterity was incorrect.

### 4.4 Modifications to Form

An updated variation, named Gordon Jr., was made through CAD software to mainly address the size constraints, and secondarily improve the overall form, as shown in Figure 5.

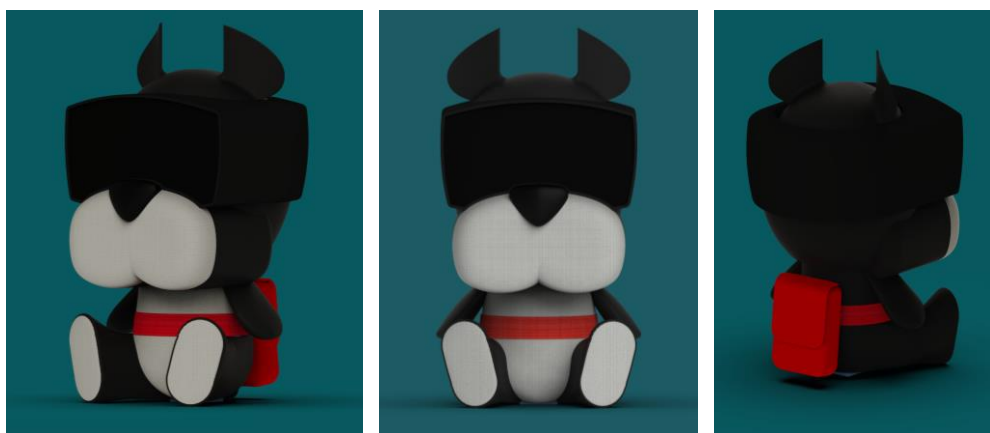


Figure 5. Gordon Jr. CAD renderings

Its overall dimensions have scaled up by 1.33x, whereas the goggle interface is now 12cm wide. Additional details were made on the legs (for a sitting position) and battery pack (indicated as the red backpack). The CAD model has been shown to the testing user for further thoughts and opinions on the aesthetics, resulting in the added newsprint colour theme.

Function wise, the mini projector feature has been removed due to the enlarged goggle interface, and to simply the toy; currently contains too many features. Details on the contents of the interface has also shifted from being a smart device to a vocal training device focusing on training and maintaining the user's ability to speak clearly (aims to reduce slurred speech). As of April 2022, the digital interface as well as physical prototype is a work in progress and will aim to be completed by summer.

## 5 LIMITATIONS OF STUDY

Research limitations include the quality and quantity of participants in the primary research stages. This study was done during a serious pandemic wave, and thus prevented the option of both interviews and face-to-face discussions or feedback. Nevertheless, this prompted a different path of conceptual designing, where the target group would be first narrowed down to a singular target user, perfecting the design, then followed by adjustments to suit a wider range of users (relatively fortunate the target user was at late stages of PD, allowing the design to be made for the extreme percentile, thus reducing the difficulty for adjustments). Note that the research period was within an annual quarterly, and significantly based on findings in HK (e.g., family as a value in Chinese culture, or distance between relatives being relatively close), hence affecting the quality and reliability of the considerations if applied to other countries. As such, it is recommended that the universal considerations be limited to having physically reduced capabilities and encouragement of positive attitudes.

Prototyping limitations include the lack of resources and time to create a functional prototype, of which affects the weight and interaction feedback. Participants in the prototyping feedback stage will need to be increased to be made in order to fully test the reliability of these considerations. As such, this study should be taken as a starting point for considerations to the design criteria for PD toys rather than a checklist, having room for improvements and confirmation in the future.

## 6 CONCLUSIONS

To conclude, when designing a toy specifically for Parkinson's Disease, the criteria should somewhat resemble one for elderlies in general, with additional considerations for the reduced capabilities. Main considerations should include the lack of mobility, low finger dexterity, decreased focus (or increased irritability), and most importantly how the toy can improve the user's mood. It is also important to clearly differentiate toys with gadgets and ensure the level of maturity perceived in both functions and aesthetics are suitable for adult usages.

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