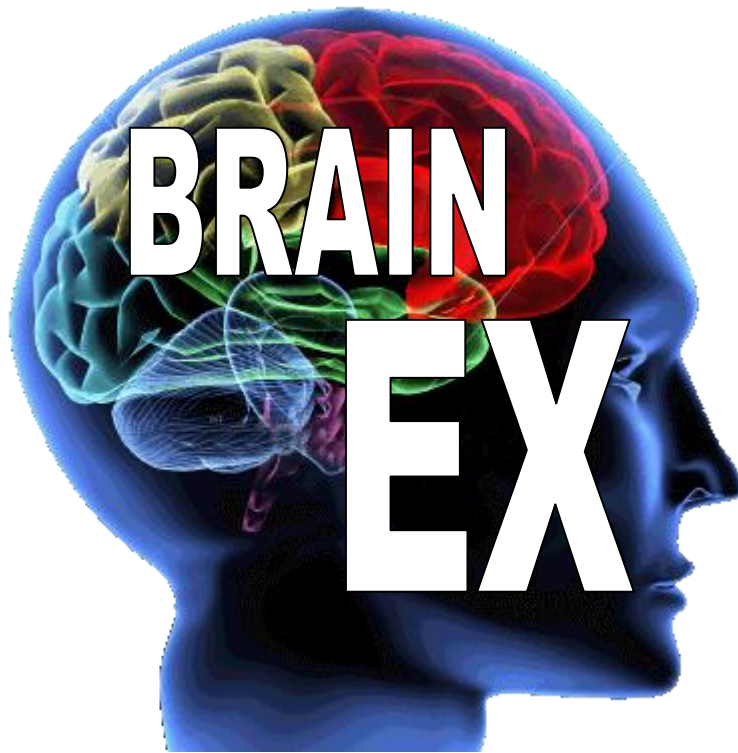


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## **EXECUTIVE SUMMARY:**

Dementia is a cognitive disorder resulting in loss of memory, changes in personality, and loss of social ability. Prevention is the key since most types of dementia are permanent and cannot be cured. Research suggests brain exercise and activities that stimulate the brain may delay memory declines and can also reduce one's risk of getting dementia and related symptoms. The BrainEx application is designed for this specific purpose. It consists of three games that stimulate the brain in different ways allowing the user to choose a game of their interest. One game will be designed to stimulate the user's memory, another game to target the user's problem solving skills, and the third game targeting both memory and problem solving skills. Each game assesses the user's performance and speed and advances the game to increase the stimulation of the brain.

## **BACKGROUND:**

Dementia is a mental disorder that affects different parts of the brain and causes impairment of intellectual abilities such as loss of memory, attention, judgment and reasoning, changes in mood, behavior and communication abilities. These symptoms may have severe affects on the person's social relationships, day-to-day activities, and performance at work. Furthermore, it is the seventh leading cause of death in Canada.

One of the most common forms of dementia is Alzheimer's disease, which accounts for 64% of all dementias in Canada. Today, half a million Canadians live with Alzheimer's disease or related dementia. In 25 years, this number will inflate to 1.3 million, most of which are over the age of 65. One in 11 Canadians over the age of 65 has dementia. Moreover, a large number of baby boomers are entering the years of highest risk, and if they live long enough, 1 in 3 will eventually develop the disease. However, although dementia is far more common in the geriatric population, it may actually occur in any stage of adulthood. Scientists believe that neurological changes of Alzheimer's begin when the brain is at its peak, closer to age 20. New statistics confirm that younger people are increasingly stricken with dementia, 15 per cent or 1 in 6 of those with dementia are under the age of 65.

Alzheimer's does not only rob the person of his/her independence and their ability to do normal every day tasks but it also directly affects the families and caregivers who look after them. Today, 17% of Canadians have someone with Alzheimer's disease in their immediate family, and 36% know of someone with Alzheimer's. Of course, these numbers will increase. In addition, dementia has also the potential to overwhelm our health care system. Studies show that the costs will increase from the current \$15 million

annually to \$153 billion annually by 2038 in Canada and a projected inability of long-term care to keep pace with the demand.

Fortunately, by making healthy lifestyle choices, a person may be able to reduce his/her risk and improve their brain's ability to sustain long-term health. There are some risk factors that can not be controlled such as genetics and growing older, but there are ways to reduce the risk of getting the disease. Most age-related losses in memory or motor skills are a result from inactivity and a lack of mental exercise and stimulation. Mental stimulation, exercise and a balanced diet can in fact help prevent or manage the disease. There is evidence which suggest that brain exercises and activities that keep the brain active may delay memory declines and other dementia symptoms. Exercising the brain increases and maintains its networks of connections. This means, a healthy brain can withstand illness better. Medical research has shown that consistent, long-term participation in activities that stimulate the brain is associated with a more than 60 percent reduction in the risk of dementia. Increased intellectual activity during adulthood is especially protective.

Challenging the brain doesn't have to be difficult. It can be as simple as using your less dominate hand to do simple tasks, or as complex as learning a new language, but the goal is to give the brain a new experience and a workout *each and everyday*, and its never too early to start. One of the most effective ways to stimulate the brain is by playing games, and is also a fun way to do so.

## **INTRODUCTION:**

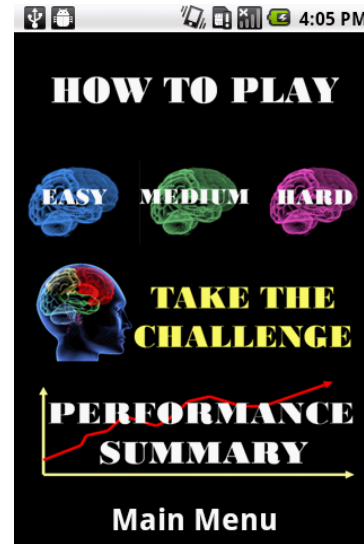
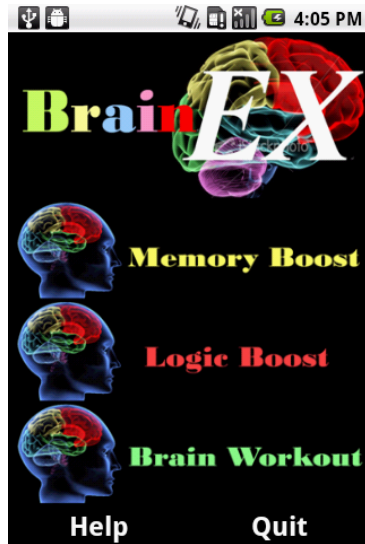
The proposed **BrainEx** application was designed based on the above information to stimulate the brain and provide today's smart phone user the opportunity to reduce his or her risk of getting dementia under their finger tips.

The application will consist of three games that stimulate the brain in different ways: one game targeting the user's memory, another targeting his/her problem solving skills, and another one addressing both, memory and problem solving skills. There are many benefits of allowing the user to choose a game. The user can choose to focus on working on enhancing his/her memory if that's their weaker point. Also, people tend to quit playing games that are too hard or not of interest to them, so having the option of picking a game that is interesting and fun while considering the users abilities is a bonus. Each game in the application assesses the user's performance and speed, and advances the game to increase the stimulation of his/her brain.

BrainEx will not only be a useful tool to reduce a person's risk of getting dementia, but it is also a fun way of stimulating the person's brain which may also result in a healthier life style, better performance at work, and hopefully, sharper memory.

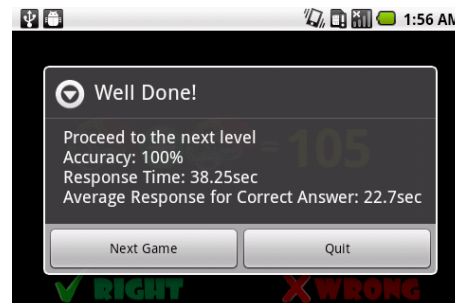
## FUNCTIONALITY & SCREEN SHOTS:

The proposed functionality of the application is as follows. When the application is called, a screen will pop up with a “fun health fact” about the benefits and ways of exerting the brain and waits for the person to press anywhere to go to the main menu, which is a screen consisting of three buttons representing each of the above games. Based on the user selection, the game will start.



### 1) Memory & Problem Solving Game:

This game stimulates the user's memory and arithmetic skills. The game starts by presenting the user with a number on the screen, randomly selected (e.g. 7), for a predetermined time, expecting the user to remember it. After a certain period, a mathematical operation sign appears (addition, subtraction, multiplication, or division) and the first number is hidden by a brain image first, and the second number follows. Once both numbers are hidden the user performance timer starts and the application waits for the user to input an answer. Once an input is received, the answer is assessed and the user's accuracy and time performance statistics are displayed with a feedback message. If the answer is correct, the user can go to the next game or quit. If the answer is wrong, the user has the option to repeat this game, skip to the next game, or quit.



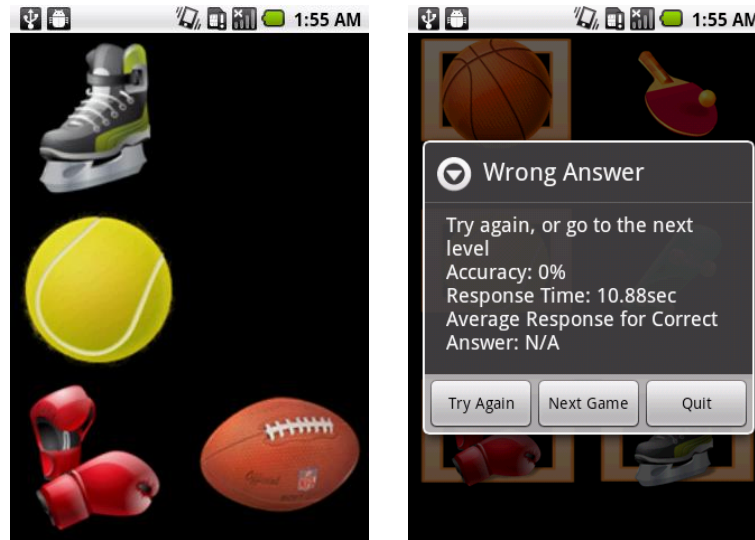
## 2) Problem Solving Game:

This game stimulates the user's arithmetic skills. It consists of a screen which contains 3 brains with numbers. The left brain carries the first number to be added, subtracted, multiplied, or divided. The middle brain carries the second number, and finally, the right brain carries the answer. Between the left and middle brain, an arithmetic operation is shown to indicate the operation type, and an equal sign is shown between the middle and right brain to complete the mathematical equation. The game consists of 3 different levels: easy, medium and hard. The easy level provides the user with mathematical operations that add, subtract, divide, and multiply only single digit integers selected randomly. This includes hiding the operation sign and providing the result, hiding one of the numbers and providing the second number, operation sign, and result. The medium level works the same way, except, instead of using 2 single digit integers this level will have one of the left and middle brains to carry a 2 digits integer sign. The hard level will similarly allow both brains to carry a 2 digit integer sign. Furthermore, the player's reaction time will be recorded and used to provide the next equation/game.



## 3) Memory Game:

This game stimulates the user's memory and attention. In this game, various shape of symbol (e.g. animals, cupcakes, drinks, foods, fruits, sports) appears on the screen sequentially, and the user has to concentrate and memorize the symbols and the sequence in which they appeared. The user is then provided with a screen showing random symbols, including the symbols that were presented to him/her earlier, and waits for the user to select the correct symbols and sequence in which they appeared. The game contains 3 levels: easy, medium and hard. In the easy mode, only 2 simple symbols are displayed with 2 second interval. For the medium mode, 4 symbols are displayed with 1 second interval and for the hard mode, 6 symbols are displayed with 900ms interval.



#### 4) Performance Summary:

After user plays the game, user's performance is stored. For each level, total number of game, and number of correct and wrong attempts are stored. Also, when user corrects the answer, user's response time is saved. With these stored variables, performance summary delivers user's accuracy and average response time when the answer is correct. Based on this performance summary, user can know how they well they are doing on the games and can check their advancement.

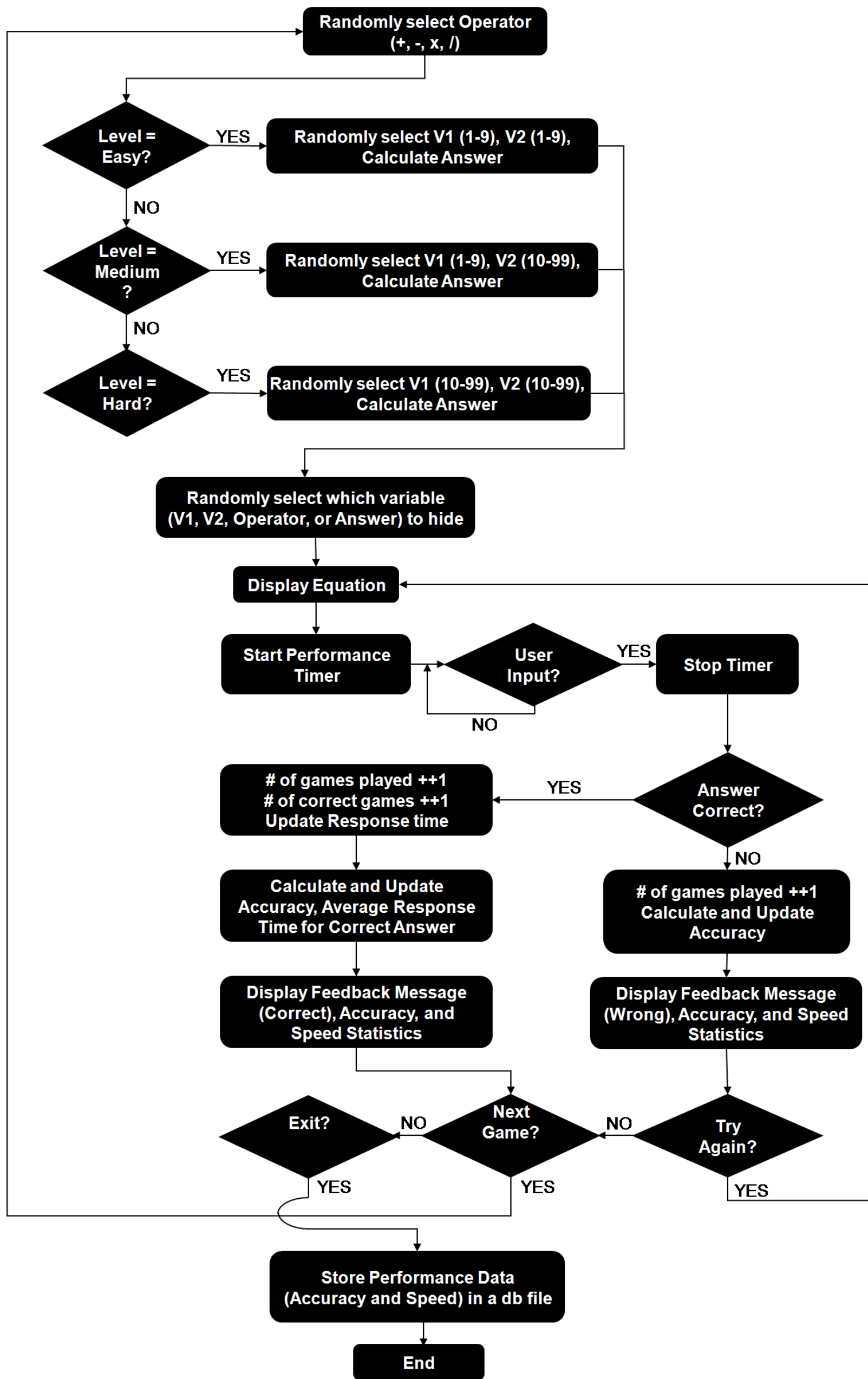


#### 5) Challenge:

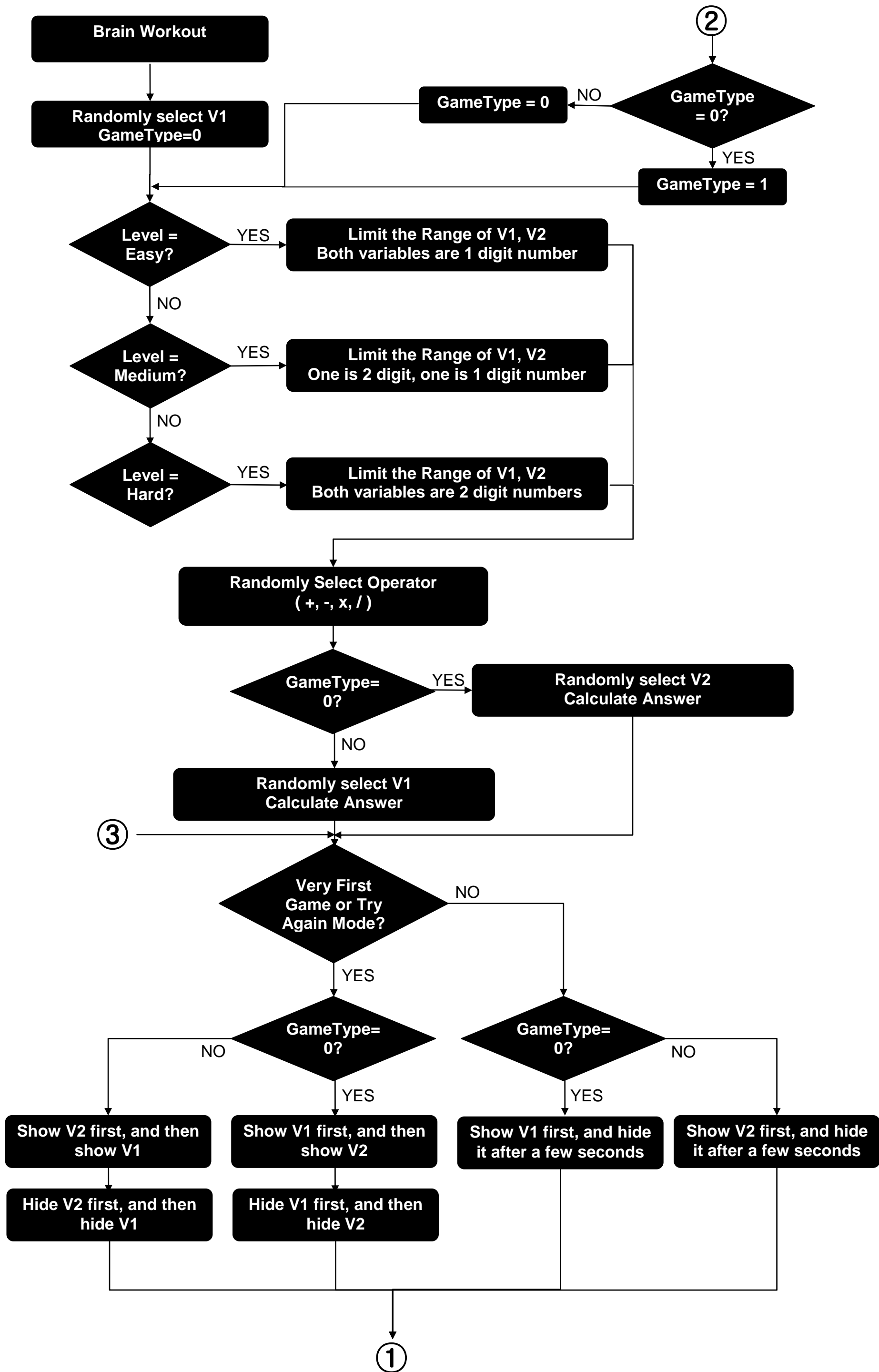
When user chooses challenge mode, the application tests user and measures performance. First, easy level problems are delivered. Users need to correct 5 problems of easy level in order to proceed to the medium level. Medium level works similar. After user corrects 5 medium level problems, the level becomes hard, and after 5 hard level problems are solved correctly, feedback message is shown. Feedback message shows if accuracy and response time is good or bad for each level.

# OVERALL DESIGN:

<Logic Game – LOGIC BOOST>



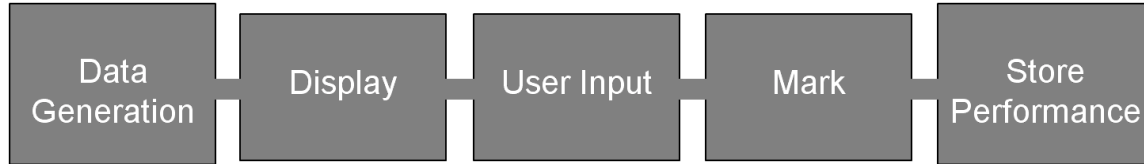
<Memory and Logic Game – BRAIN WORKOUT>







### <General Flow of Three Games>



Three games follow general logic flow as shown above. For Data Generation, logic game (Logic Boost) and logic & memory game (Brain Workout) generates an equation; two variables (V1 and V2), operator and answer. Data generation for memory game (Memory Boost) would be selecting symbols that would be displayed. Display and user input part for each game is different. For Logic Boost, an equation with one part is missing is displayed with keyboard that user can use as input method. For Memory Boost, symbols are appeared one by one in a certain order. After some symbols are displayed, it provides six symbols as user input, which includes the symbol provided in display part. Brain Workout displays two variables and hides it with brain image and show the operator and answer. If user thinks the equation is correct he/she can choose right button, and if not, he/she can choose wrong button. Mark part compares the correct answer and user input, and determine if user got correct answer or not. When user gets the answer correct, application stores the user's response time. Also, the total number of game played and how many problem users got correct is stored at Store Performance part. With these stored data, application delivers the accuracy and response time to user.

## **LESSONS LEARNED:**

Learning Java and how to program android phones was probably the most challenging part of this course and was quite time consuming, especially since both of us have never used Java before. However, it was all worth it at the end and it's a great skill to have especially at this current time. Having gone through this course, we both feel confident to implement any future application ideas efficiently as we have now gained knowledge of the programming language and environment and learned to set realistic goals for the design milestones. The use of the spiral method specifically helped us keep focused and stay on track to meet our goals. Furthermore, we also believe that having a clear idea of the over all design and functionality in the first stages of the design is very crucial. Overall, the experience gained from this project was very interesting and definitely valuable.

## **CONTRIBUTIONS:**

Both team members contributed equally to the design and development of this application. We met on regular basis to discuss the design and how to implement the required functionality and worked in parallel to achieve goals on time. Most of the code

implementation was done by Jinyoung, where the logic of functionality and design was done by Rowa.

## **FUTURE WORK:**

There is some additional functionality that could be added to this application. This may include adding sound effects, enhancing the graphic design, creating a server data base to collect participants performance statistics and allowing the user to compare his/her scores to the other users, adding more images to the memory game, and also adding a healthy tips pop-ups option that the user can enable or disable which can motivate the user to stay healthy. Furthermore, additional games that specifically targets attention, flexibility, and speed may also be added to provide the user more ways to stimulate his/her brain.

Word Count: About 2200 words