

EMPATH

Research & Concept Development
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IDES 4310

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*"Counterintuitively, in an information-rich world advances in technology
can increase, not decrease, cognitive demands on users."*

-Ann Mansur

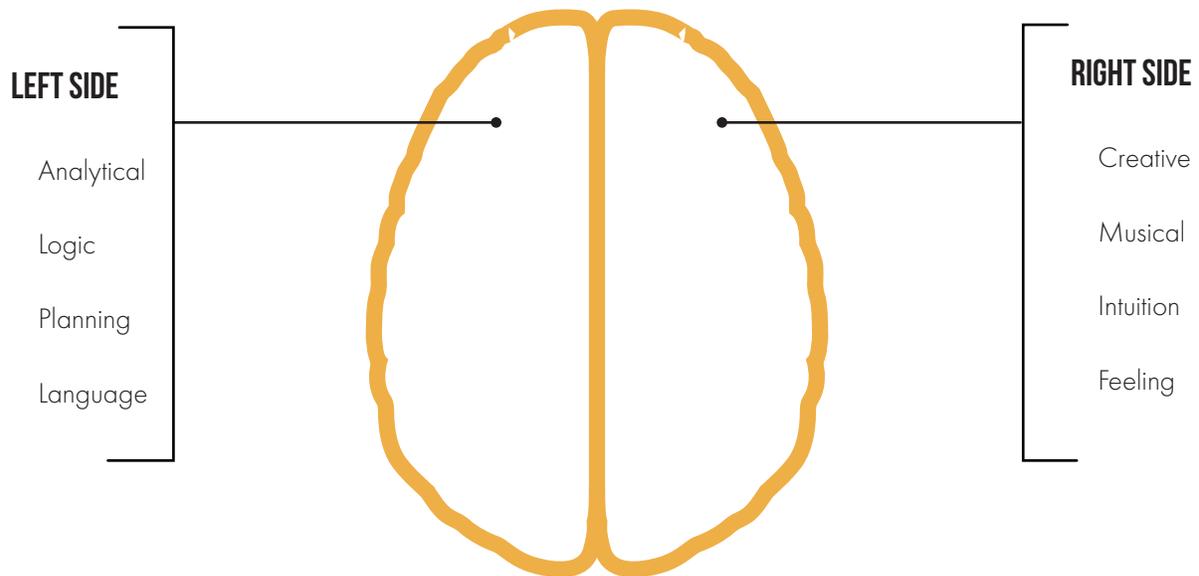


RESEARCH

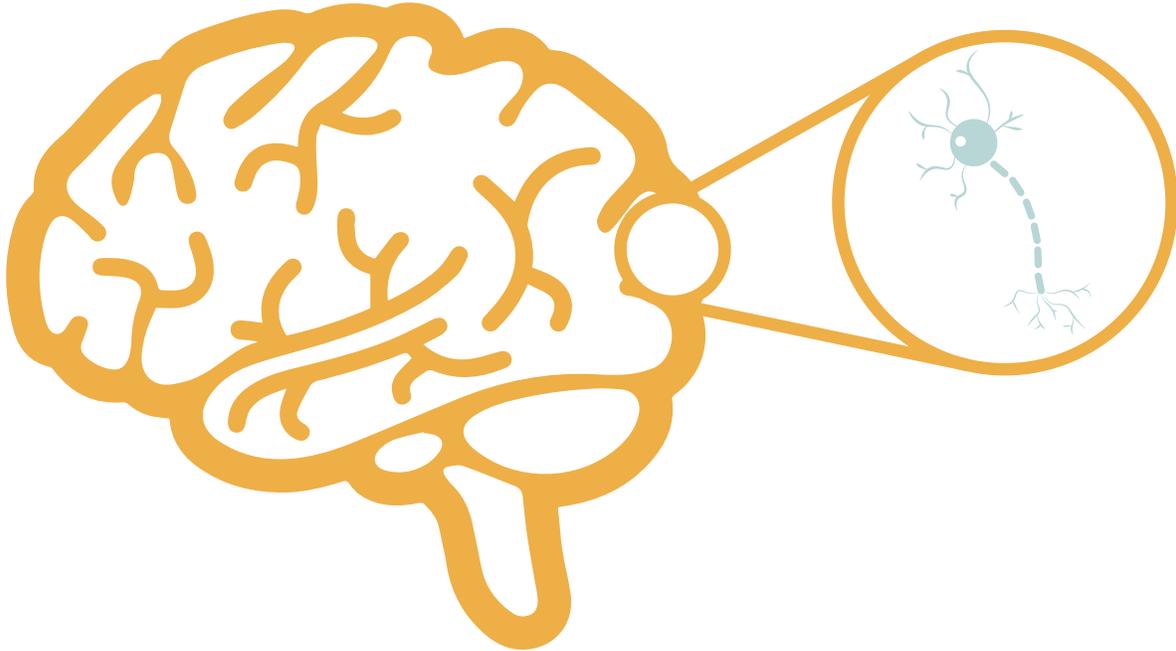
ABOUT THE BRAIN

The brain is a vastly complex organ that controls every process in the human body. (Mayfield Brain & Spine, 2018). Every thought, creative idea, emotion, and memory is produced by a series of neurochemical reactions, with some regions of the brain designated to regulating certain parts of human functioning. (Mayfield Brain & Spine, 2018). The brain is separated into two halves, each half controlling the opposite side of the body (Mayfield Brain & Spine, 2018). The left side of the brain controls speech, logic,

and writing, generally more of the analytical processes. The Right side of the brain focuses on more creative processes, such as creativity, spatial ability, and musical skills (Mayfield Brain & Spine, 2018). Furthermore, the brain is broken down into lobes, each with their jobs. Connecting all these areas is white matter (Balm, 2014). White matter is the messenger that relay information from one side of the brain to another, acting as the information interstate (Balm, 2014).



TRAUMATIC BRAIN INJURY



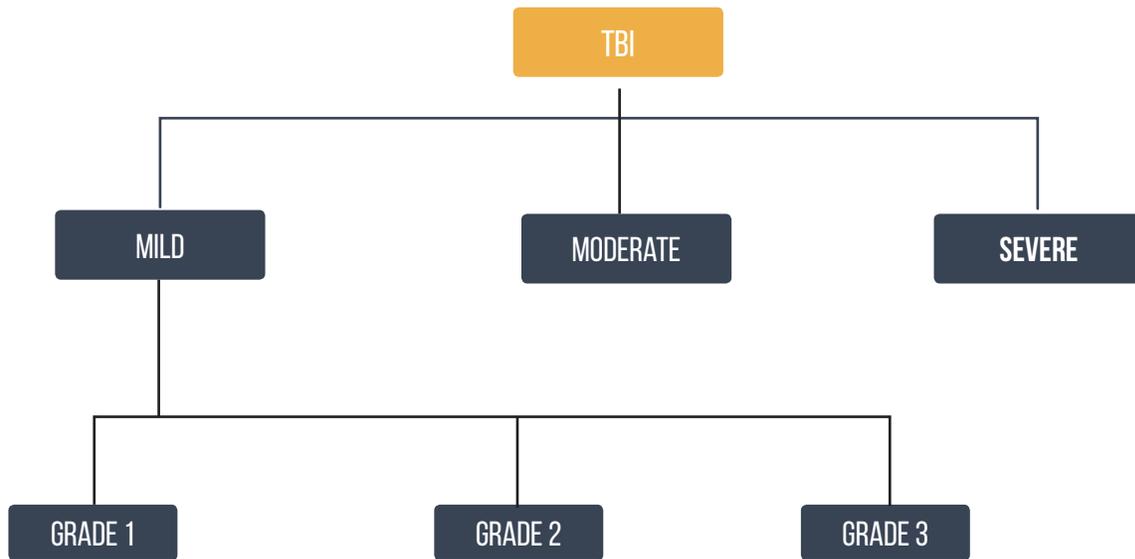
A head injury can range from any sort of trauma to the head; this can be anything from bumps and bruises and cuts, fractures and, traumatic brain injury (Columbia University, n.d.). The sheer amount of injuries occurring combined with the severity of these injuries makes head injuries one of the leading causes of disability and death in adults (Columbia University, n.d.).

When the brain suffers an unobtrusive wound that occurs with sudden impact, there is a cascade of neurochemical changes that occur within the white matter of the brain (Leddy & Willer, 2006). It can take hours and even days for this microscopic shift to occur, explaining why there can be a delay in symptoms that are presenting after an individual receives a blow to the head (Leddy & Willer, 2006). The impact can cause inflammation, the production of harmful chemicals, and damage nerve fibers beyond repair (Menon, 2015).

The brain, being a delicate interconnected system of chemicals and neurons, suffers greatly when injured (Columbia University, n.d.). This is why head injuries of any sort are extremely dangerous and take a real mental strain on an individual.

SEVERITIES OF TBI

Our current understanding of the brain and how it functions leaves many unanswered questions (Gorman, 2014). As with most things we don't understand, scientists have broken types of brain injuries down into categories. Allowing doctors to treat injuries with the best tools we currently have. However, despite all this organization, there is still a lot of debate in the neurological community as the definitions of each of these categories.



As with any injury the severity tends to exist on a spectrum, this spectrum is a sliding scale that reflects the type of treatment plan and care that an individual may need. The spectrum ranges from mild, to moderate, to severe. The least severe of the of the three is called a mTBI, more commonly referred to as a concussion. The most widely accepted definition comes from the American Academy of Neurology (AAN), who state that a concussion “is a trauma-induced alteration in mental status that may or may not involve” (Leddy & Willer, 2006). The concussion category is further broken down into 3 grades, with each grade being defined by amnesia, balance, and level of consciences (Dolman Law Group, 2019). A moderate injure is defined by loss of conscious for a few hours and confusion that can last for month (Dolman Law Group, 2019). The severe

category is reserved for life threatening injuries where the prognosis is that they victim will not be able to return to the same slandered of living as before the injury (Dolman Law Group, 2019). The injuries suffered with moderate to severe TBI are often permanent (Leddy & Willer, 2006) , changing the way of life for the sufferer.

POST CONCUSSION SYNDROME

Post Concussion syndrome (PCS) is a condition that occurs to up to 15% of individuals with concussions that alters the way they live their lives, leaving them to deal with symptoms of their concussions for much longer than the regular recovery time (Leddy & Willer, 2006). Some suggest that individuals who have PCS have a semi -permeant brain injury.

IMPAIRMENT

Suffers from concussions must live, at least for a short amount of time, with impaired cognitive function. When recovering from a TBI, the most common course of action taken by doctors is to put patients through neurocognitive rehabilitation therapy (Leddy & Willer, 2006). In addition, doctors recommend avoiding anything that causes symptoms to become aggravated (Leddy & Willer, 2006). Some of the most common symptoms include degraded alertness, sleep problems, cognitive impairments, and debilitating headaches (Raikes & Killgore, 2018).



SLEEP

The reason is not yet known, but TBI impact on sleep is profound, leading to chronic sleep loss or detrimentally altered sleep patterns (Raikes & Killgore, 2018). This can be long term and can impair the recovery process and everyday life (Raikes & Killgore, 2018).



COGNITION

The amount of impairment to cognitive functioning can be extremely debilitating, with attention memory, executive functioning, and visual-spatial processing (Raikes & Killgore, 2018). These factors render everyday living difficult as victims often do not have the mental capacities to complete simple tasks (Raikes & Killgore, 2018).



MOOD

The change that occurs with the chemicals in the brain can cause depression, in addition to the cognitive impairments that often cause emotional distress (Fann & Hart, n.d.). Depression affects up to 42% of adults suffering from TBI's (Raikes & Killgore, 2018).



OVERSTIMULATION

The ability of the brain to filter stimulus is vastly altered when recovering from a TBI (Dealing with overstimulation, n.d.). Individuals easily become overstimulated as the nervous system goes into overdrive as it attempts to process all the sensory information it is receiving (Dealing with overstimulation, n.d.). The impacts this has are astronomical and will be further discussed later.

VISUAL STIMULUS

Outwardly these symptoms result in poor coordination, difficulty communicating, personality changes, and reduced ability to partake in everyday life.

Overstimulating the brain causes aggravated symptoms hindering recovery (Raikes & Killgore, 2018). The majority of the stimulus that enters the brain is from the visual pathway. Due to the fact that TBI compromises eye movement, it is easy for patients to aggravate symptoms when engaging in activities that have a visual component (Ventura, Balcer, Galetta, & Rucker, 2015).



SACCADES

Saccades movement is a complex process that occurs when they focus on the eyes quickly shift from one point to another (Ventura, Balcer, Galetta, & Rucker, 2015). Patients with a TBI or PCS have been seen to struggle with saccades movements. This kind of eye movement is critical for reading or observing a room. (Purves D, 2001)

SMOOTH PURSUIT

Smooth pursuit is a slower tracking that keeps moving objects in focus. Impaired brains are unable to predict the location of the target (Ventura, Balcer, Galetta, & Rucker, 2015). This is critical when watching a movie or driving (Purves D, 2001).

CONVERGENCE INSUFFICIENCY

Convergence insufficiency occurs because the brain is unable to focus the eyes on a particular point (Ventura, Balcer, Galetta, & Rucker, 2015). There is a high rate of Convergence insufficiency in individuals who have suffered a TBI. As the brain is unable to focus the eyes, it ends up overexerting itself, often causing symptoms to flare (Ventura, Balcer, Galetta, & Rucker, 2015).

LIGHT

Exploring the visual pathway further, it's crucial to observe light. Light affects almost every part of human functioning, helping regulate the release of hormones, cognition, mood, and alertness (Raikes & Killgore, 2018).

The human eye can see light waves from 380nm to 700nm (National Aeronautics and Space Administration, 2018) various wavelength promote various functions in the brain (Raikes & Killgore, 2018). Figure 1 is a visual representation of when various light waves are beneficial throughout the day.

Blue light exposure in the morning is shown to minimize fatigue throughout the day by kickstarting the circadian rhythm and thus increasing alertness (Raikes & Killgore, 2018). There are some studies that show blue light having positive effects on cognition (Raikes & Killgore, 2018).

Various animal models suggest that green light has sleep promoting properties, along with minimizing headaches for migraine sufferers, making it beneficial in the evenings (Raikes & Killgore, 2018).

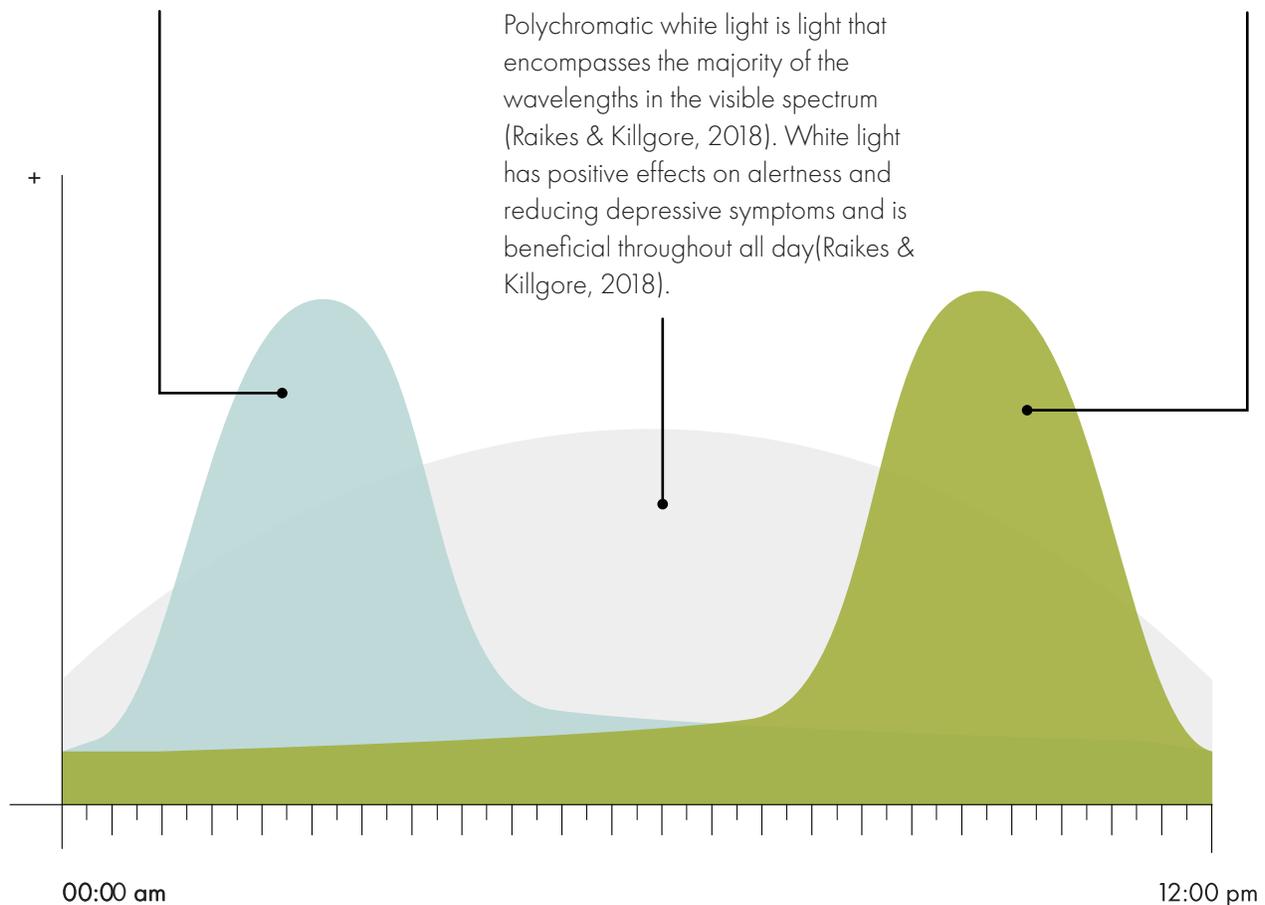


Figure 1: Beneficial light throughout the day

SCREENS

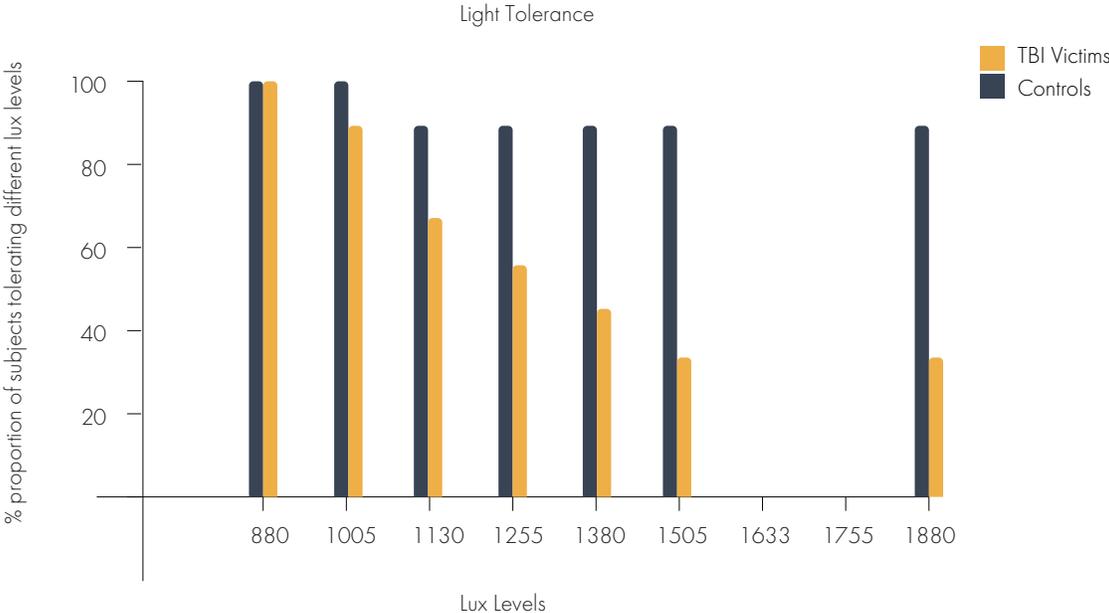


Figure 2: Light tolerance comparison between TBI victims and a control group. Adapted from "Sensitivity to light and sound following minor head injury," P. A. Wadell and D. M. A. Gronwall, 1984, Acta Neurol Scand, p 273

BRIGHTNESS

Due to the inability to regulate stimuli, screens and light are highly debilitating due to the impact it poses on everyday life, particularly in a world so reliant on technology (Mansur, et al., 2018). Suffering from a TBI greatly minimizes the amount of light an individual can tolerate, not only during the recovery process, but for months afterward, figure 2 shows the limited tolerance for light (Waddell & Gronwall, 1984).

SCREENS

When suffering from a TBI, the ability for the brain to perceive the refresh rates of screens is heightened, which exhausts the brain (Mansur, et al., 2018). LCD screens greatly aggravate symptoms due to the intense contrast and refresh rate of the screen, in which an injured brain has a harder time fusing the images together (fig 3). A study comparing LCD to an E-ink Screen shows that E-Ink screens did not aggravate symptoms and was a more enjoyable experience for sufferers (fig 4) (Mansur, et al., 2018). Users from this study state that they would purchase an E-ink product to reduce symptoms if the cost was reasonable (Mansur, et al., 2018).

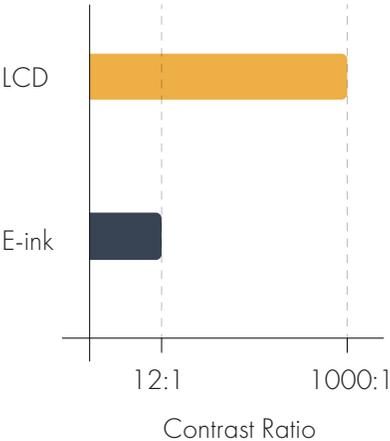


Figure 3: Contrast of LCD vs E-ink

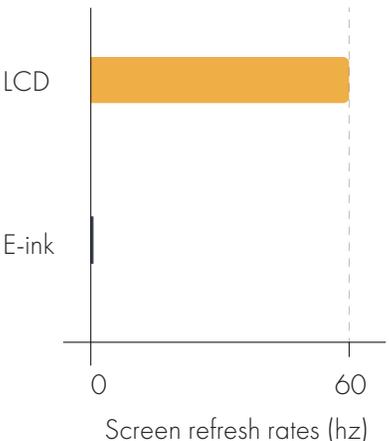


Figure 4: Refresh rates of LCD vs E-ink

USABILITY AND ACCESSIBILITY

There are common design practices that are commonly used to ensure digital interfaces can be used by individuals with cognitive impairments. Create a system that minimizes the opportunity for error. Due to memory impairments it's important to avoid asking users to input information that may require them to open a wallet or search for information, such as phone numbers (MIT, ERCIM, Keio, Beihang, 2015). Extra steps make tasks seem more daunting and difficult for users, particularly when dealing with cognitive impairments (MIT, ERCIM, Keio, Beihang, 2015).

BARRIERS

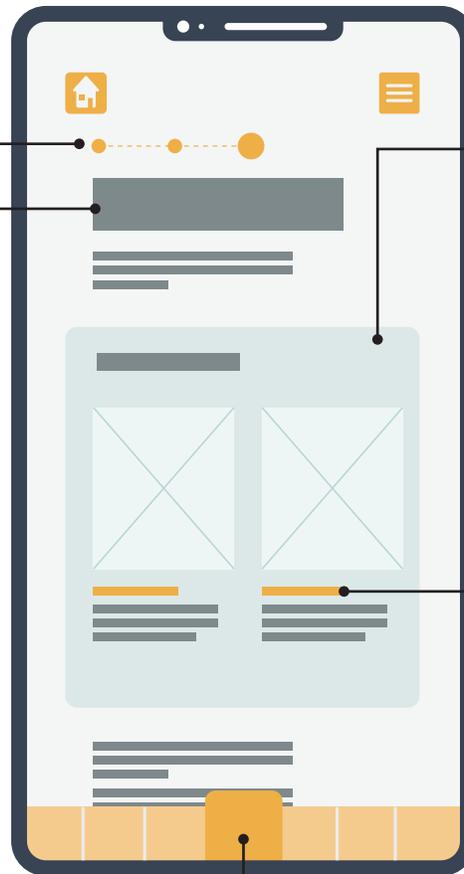
Be wary to avoid designing in barriers. Frequently security measures, such as passwords, form barriers due to the demand on the individual to remember information. It's important to remember the users limitations when designing (MIT, ERCIM, Keio, Beihang, 2015).

FOCUS

By showing breadcrumbs users who frequently lose their train of thought or impaired memory are able to become reoriented and continue on with their task (MIT, ERCIM, Keio, Beihang, 2015).

CLARITY

Clear titles that summarizes the page and its purpose helps users when they struggle to remember what they are doing (MIT, ERCIM, Keio, Beihang, 2015).



CHUNKING

Allows for more manageable organization of information, and helps the user find their spot if they lose track (MIT, ERCIM, Keio, Beihang, 2015).

UNIFORMITY

All links, buttons or features should have a uniformed style for easy identification (MIT, ERCIM, Keio, Beihang, 2015).

NAVIGATION

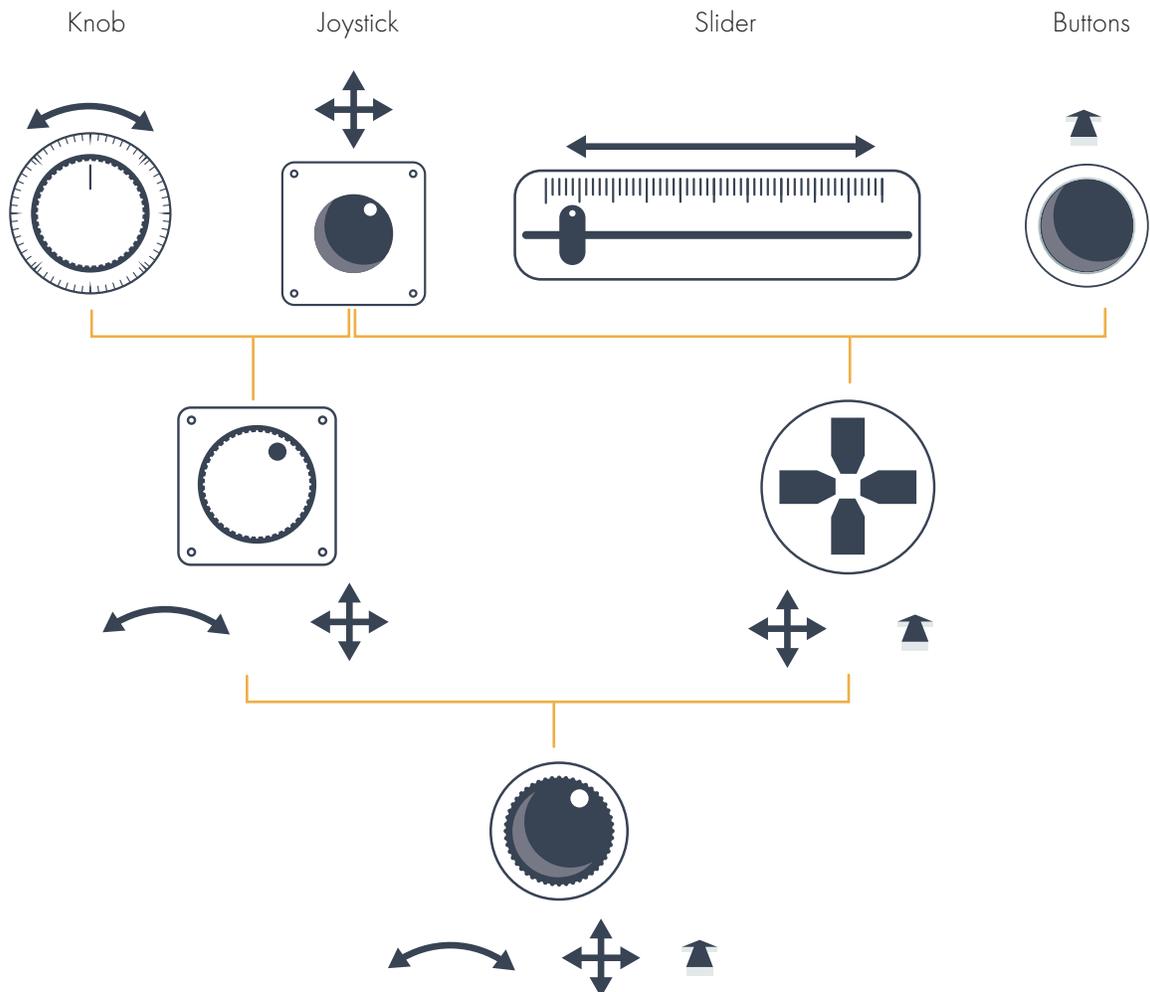
Should be easy by providing clear and concise text and speech, in addition to intuitive navigation. Using easily recognizable symbols and design patterns as individuals with impairments rely on predictable behavior in digital settings (MIT, ERCIM, Keio, Beihang, 2015).

ANALOG SYSTEMS

"of or relating to a mechanism that represents data by measurement of a continuous physical variable, as voltage or pressure." -Dictionary.com

After compiling various analog devices, it's been noted that there are four general types of analog inputs. Each being beneficial for different types of information that needs to be input. Sometimes various analog input methods can be combined to provide the user with a more fulfilling experience if one form of input is not

sufficient for all the information that might need to be entered. Some of the most common ways for these methods of input to provide feedback to the user is by light, vibration, sound, and digital displays. Providing feedback to the user is imperative to a positive user experience.



MARKET

Traumatic brain injuries (TBI) occur roughly 2.5 million times annually (Leddy & Willer, 2006). It is shown that men suffer twice as often as females; with 85% of these TBI's being considered mild (Leddy & Willer, 2006). Mild TBI's are more commonly known as concussions. It's estimated that 50%-70% of these incidents are a result of motor vehicle accidents (Traumatic Brain Injury & Concussion, 2019). It's been noted that 80% of emergency room visits for children ages 5- 19 in Canada were

due to TBI (Government Of Canada, 2019). Most of products on the market for concussions are dedicated to aiding doctors with treatment or prevention.

Dumb phones generally marketed to the elderly or to parents wanting to have a line of communication with their child. All these phones are intended to be the users main device and don't provide users with the same power as a common smart phone.

Rates of TBI Emergency Department visits in Canada

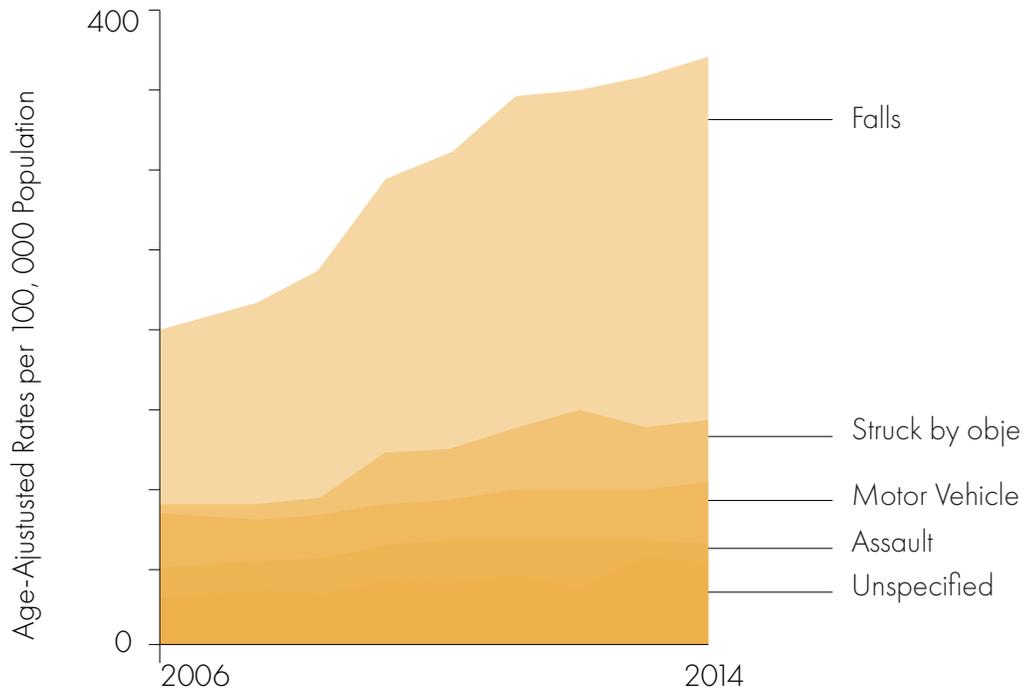
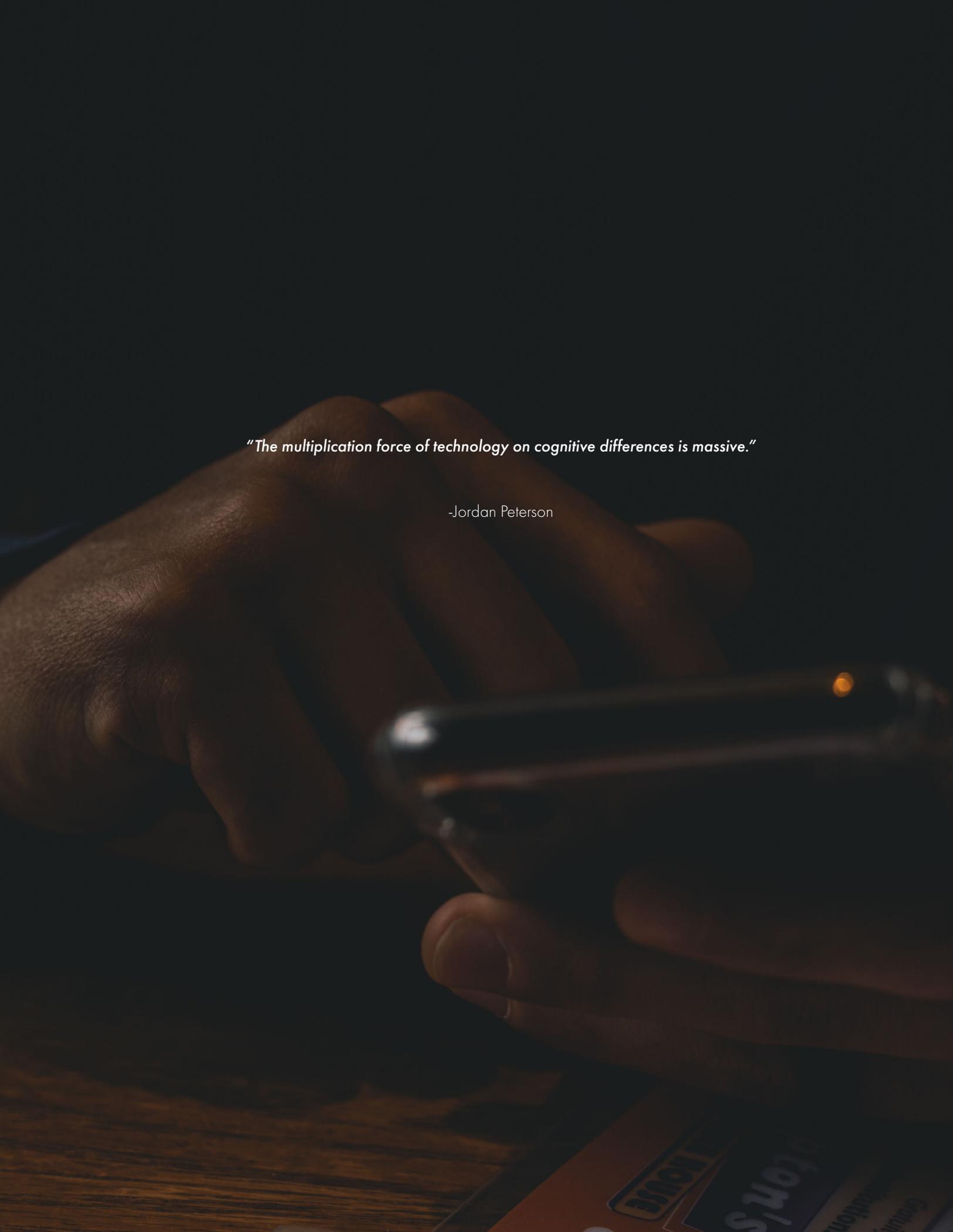


Figure 5: Rise in TBI related visits in the emergency department in Canada. Adapted from "BI-related Emergency Department (ED) Visits", CDC, Retrieved from: <https://www.lib.sfu.ca/help/cite-write/citation-style-guides/apa/tables-figures>

A close-up photograph of a hand holding a smartphone. The scene is dimly lit, with the primary light source coming from the phone's screen, which is partially visible and glowing. The hand is positioned in the center-left of the frame, with fingers wrapped around the device. The background is dark and out of focus. In the bottom right corner, a portion of a document or book cover is visible, featuring the text 'LIFE' and 'LIFE'S' in a stylized font.

"The multiplication force of technology on cognitive differences is massive."

-Jordan Peterson

CONCEPTS

GOAL:

To create a device able to temporarily attach to a smartphone that provides users with an analog interface in order to relieve them from cognitive strain.

PRIMARY DESIGN CRITERIA

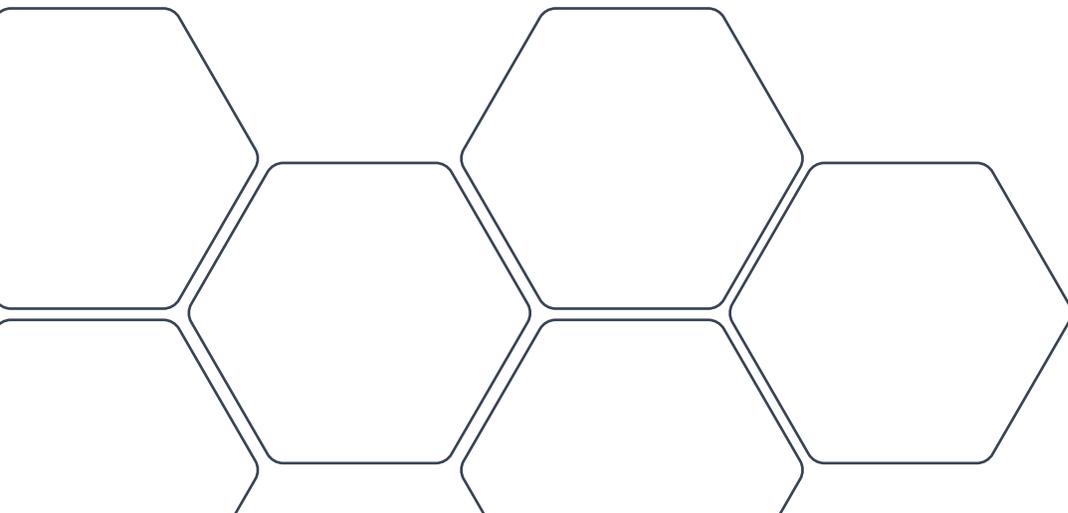
- Not aggravate symptoms of an individual with cognitive impairment
- Provide analog interface for phone
- Temporary simplify phone navigation

SECONDARY

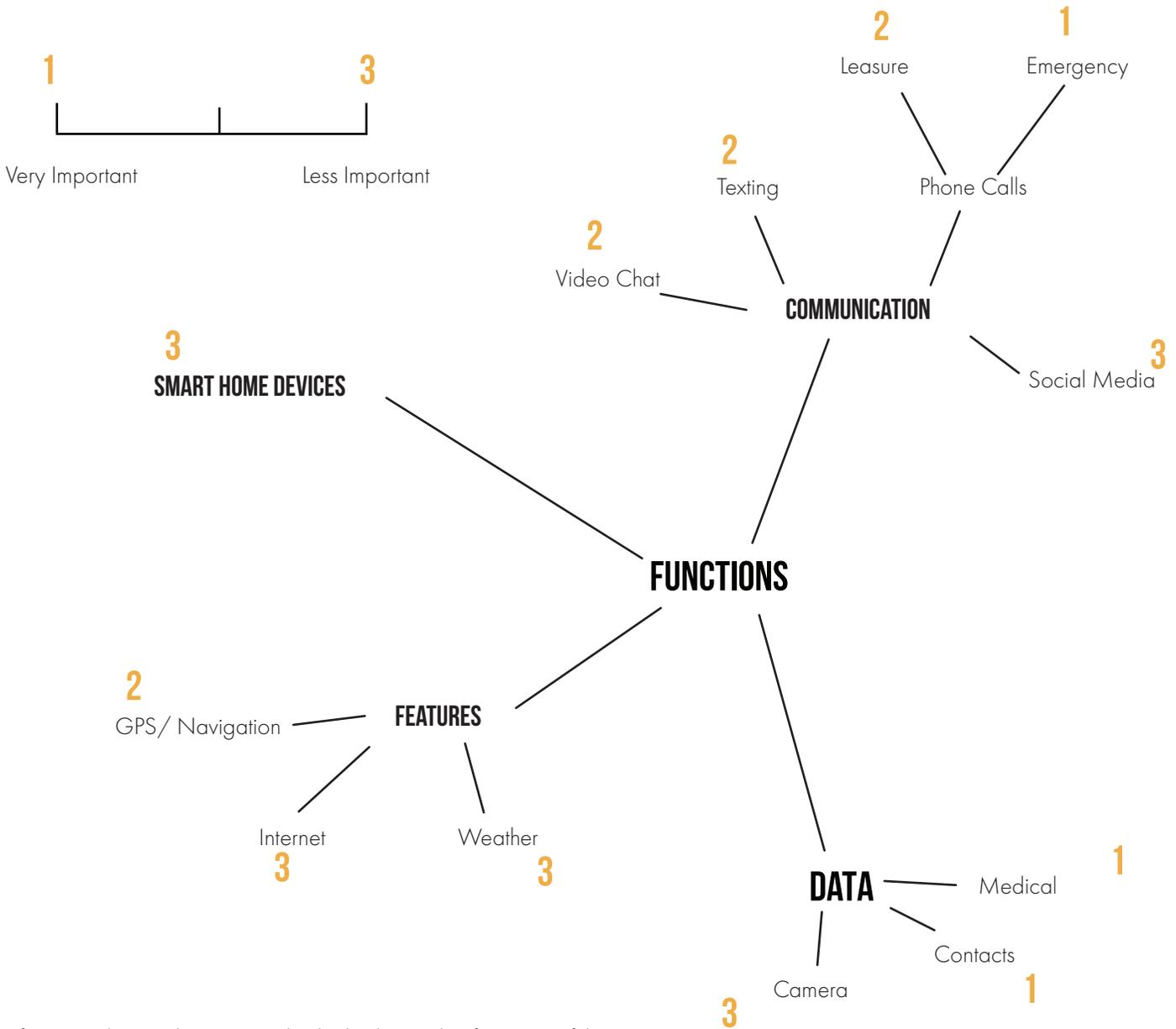
- Allows for portability
- Simplify phone functions to bare necessities

TERTIARY

- Durable design that can withstand falls



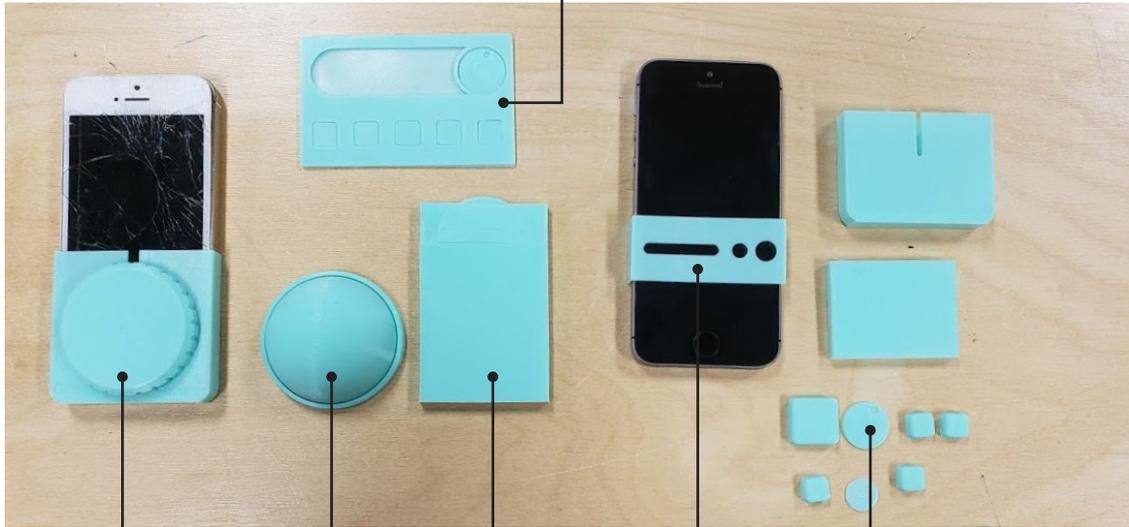
PHONE FUNCTIONS HIERARCHY



After consulting with various individuals about what functions of the phone they consider the most important, I created a mind map to organize and illustrate what was determined to be the most critical functions of a phone. This will enable me to design a device that allows users to complete the most important tasks on their phones without unimportant or distracting features — thus removing the amount of cognition needed to navigate the device.

EXPLORATION

Case that slides over screens, causing various options to appear



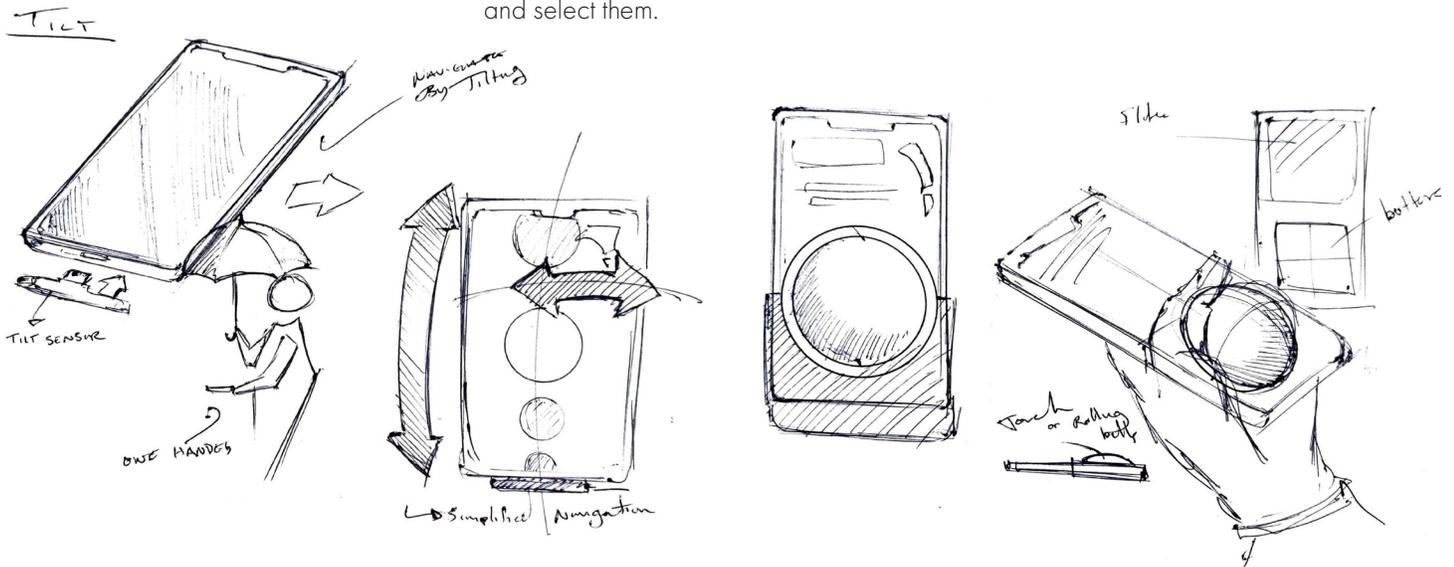
Large knob that can be pressed, allows for easy one hand use. In this prototype it allows part of the screen to be seen, utilizing it as a display.

Large touch surface, acts like Ipod Touch with the circle click wheel

Experimenting with partial covering of the screen allowing openings to be used as buttons and sliders

Printing out various sized buttons allowed me to place them freely on the phones to explore various options.

A partially exposed knob on the side of the phone near thumb placement that can scroll through functions and select them.



NEXT STEPS

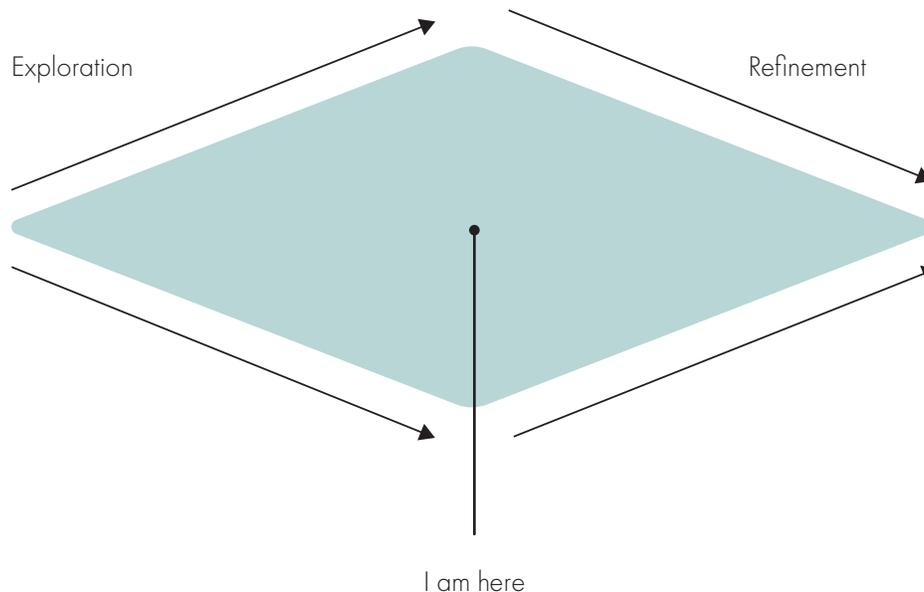
INVESTOR

Getting an investor involved is important for most entrepreneurs. An investor can provide the financial investment needed to kick start a company. Potential investors could include various medical societies as not only would they be interested in a product that addresses a problem that as yet been addressed in their field, but it would also be beneficial to the launch of the product. If doctors are recommending the product to patients with any sort of cognitive impairment, word will spread, and individuals who may not have severe conditions will hear about the product and seek it out, thus creating more demand for the product.

REFINE CONCEPTS

Much more work needs to be done to refine concepts. User testing of various analog concepts and screen coverings need to be completed in order to find the most intuitive and simple solution. It will be important to continuously user test every iteration of the concepts. Creating realistic prototypes of various screen options will be needed to complete user testing properly.

The concepts that I will develop more will include using a different screen as a primary display, such as an E-ink screen or LED displays such as Samsung's LED case, in conjunction with various analog inputs. Primary exploration will go into having a single knob with the screen as the knob face.



EMPATH

TRAMATIC BRAIN INJURY

When suffering from a head injury, the inability to preform everyday tasks is devastating to a person's mental well-being and recovery. Victims suffer from memory loss, depression, fogginess, severe headaches and are able to become over stimulated very easily. Traumatic brain injuries (TBI) occur roughly 2.5 million times annually. It is shown that men suffer twice as often as females; with 80% of these TBI's being considered mild. Mild TBI's are more commonly known as concussions. It's estimated that 50%-70% of these incidents are a result of motor vehicle accidents. Its been noted that 80% of emergency room visits for children ages 5- 19 in Canada were due to TBI. With brain injuries more so than other injuries, a healthy state of mind is critical to a fast recovery. A key aspect in the recovery process is avoiding symptom stimulating activities such as using mobile phones and engaging in mentally or physically exhausting activities. As TBI victims are unable to use their mobile phones, which for most people is a significant communication device, their ability to alleviate social isolation and engage in everyday tasks diminish. The screen brightness and mental load required to operate mobile devices often proves to be too difficult.

Opportunity lies in creating a device that reduces the cognitive stimulation that is required to use mobile phones by creating an analogue interface and help victims return to everyday activities as soon as possible. Currently there are no products on the market that accomplish this task. By creating a product that can be used by individuals with such a fragile state of mind without aggravating their symptoms, it opens the door to the device being used by any individual who may suffer from other forms of cognitive deficits such as migraine sufferers or stroke victims.



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