

SYNAESTHESIA MATERIALISATION

Approaches to Applying Synaesthesia as a Provocation for Generating Creative Ideas Within the Context of Design

Chang Hee Lee

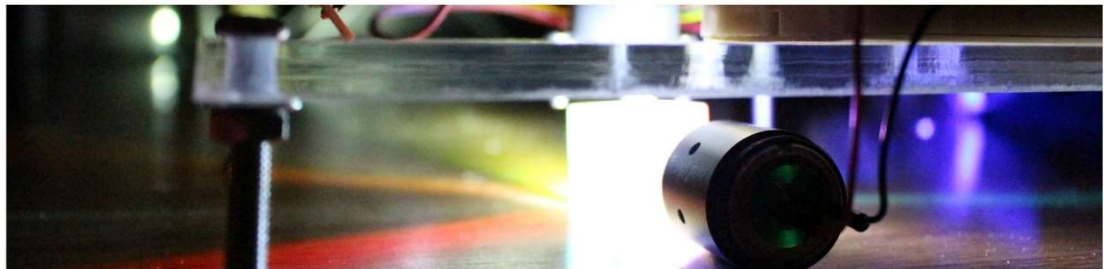
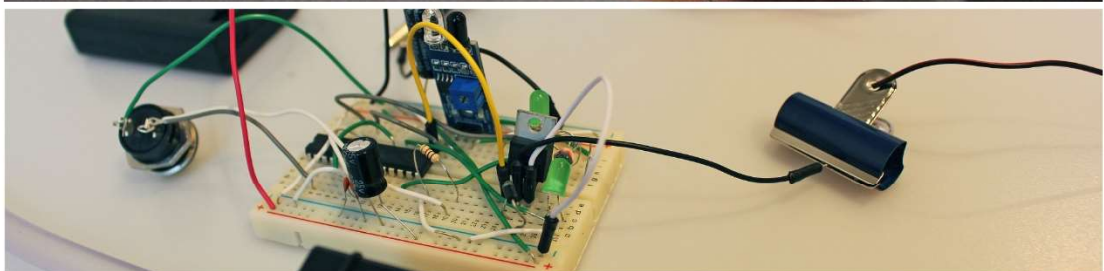
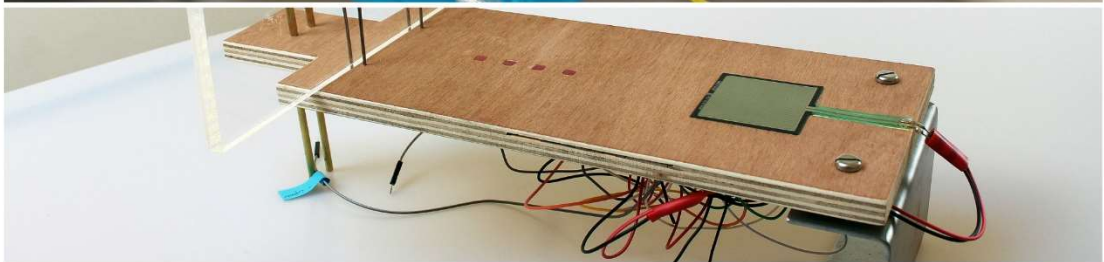
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September 2018



Royal College of Art

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ABSTRACT

For the past three decades, research on the topic of synaesthesia has been largely dominated by the field of psychology and neuroscience, and has focused on scientifically investigating its experience and causes to define the phenomenon of synaesthesia. However, the scientific research on this subject is now enquiring into potential future implementations and asking how this subject may be useful to wider audiences, and is attempting to expand its research spectrum beyond the mere scientific analysis. This PhD research in design by practice attempts to contribute and expand this scope: it shares a creative interpretation of synaesthesia research and questions its existing boundary.

The past synaesthesia research in design has been largely focused on the possibility and potentials of sensory optimisation and cross-modal sensory interaction between users and artefacts. However, this research investigates the provocative properties and characteristics of synaesthesia and shares different approaches to its application for generating creative ideas in design. This PhD research presents nine projects, and they consist of approaches to synaesthesia application, toolkits and validations.

Synaesthesia is one of those rare subjects where both science and creative context intersect and nurture each other. By looking into this PhD research, readers may gain insights of how a designer tries to discover a new value within this interdisciplinary context. This research contributes three types of new knowledge and new perspectives. Firstly, it provides a new interpretation and awareness in and of synaesthesia research, and expands its research boundaries, moving from analysis based research to application based research. Secondly, it outlines three approaches, a range of themes and toolkits for using synaesthesia as a provocation in generating creative ideas in the design process. Thirdly, it identifies the differences between previous synaesthesia application research and current application research within the context of design.

Research on the topic of synaesthesia has been boosted significantly since the technological innovations (e.g. fMRI brain scanning and neuroimaging) in the early 1990s.

However, this research was somewhat limited to scientific analysis analysis in order to understand the nature of the phenomenon. This research paradigm and the scientific focus have now shifted, and they are attempting to discover the potentials of synaesthesia's usefulness through different disciplines and channels. How can we apply the provocative qualities of synaesthesia within the context of design? This research journey begins by investigating this foundational question from a designer's point of view.

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AUTHOR'S DECLARATION

During the period of registered study in which this thesis was prepared the author has not been registered for any other academic award or qualification. The material included in this thesis has not been submitted wholly or in part for any academic award or qualification other than that for which it is now submitted.

Signature:

Date: 23. September. 2018

Supervisors:

Dr. John Stevens

Dr. Dan Lockton

1. INTRODUCTION

Until the early twentieth century, the subject of synaesthesia has typically been dismissed by mainstream science as no more than an overactive imagination or a kind of hallucination. However, there was a growing critical mass of young scientists unafraid of challenging orthodoxy. Furthermore, technological innovation allowed the field of neuroscience to identify objectively this subjective phenomenon, and research in the field has increased significantly since the early 1990s (Harrison, 2001, p.vii). Although the definition of synaesthesia is well settled and commonly understood, researchers still search for its types and causes to identify this phenomenon objectively. More recently (Beresford, 2014), a new enquiry has emerged and the paradigm has broadened beyond scientific analysis to explore the potential usefulness of synaesthesia, and this PhD research attempts to explore this potential from a designer's point of view.

This thesis begins by reviewing my personal motivation and the previous projects in which I began to explore the topic of synaesthesia for this PhD study. This then moves to review assorted literature in the field of experimental psychology and modern neuroscience to understand its foundation, as the field of science has rekindled research interest in the topic of synaesthesia (Cytowic, 1993; Harrison, 2001). This research then begins to investigate how the subject of synaesthesia has been utilized in different creative disciplines and contexts, and interprets current synaesthesia literature in design research. These literature and practice reviews assisted this research in finding and refining the context and questions for this PhD.

The accumulated literatures and practice reviews led this research to observe the inspiring qualities of synaesthesia and its potential applications within the context of design. While different creative disciplines widely celebrated the obscure and inspiring qualities of synaesthesia, very few detailed design studies tried to understand its potential implementations (Haverkamp, 2013; Dann, 1998). In this context, the purpose of this doctoral research is to explore tangible ways to use intangible properties of synaesthesia as a tool for inspiration and ideation.

Three Studies of Synaesthesia is one of the key projects in this PhD research that attempted to discover the different provocative properties and characteristics of synaesthesia. The project reflects and shares synaesthetic properties to create different approaches and toolkits to apply these properties to generate creative ideas. The toolkits were developed throughout the collaborative workshops by considering and adapting them in the light of participants' feedback, concerns and experience.

The identified synaesthetic properties, methods or approaches of application, tools and projects were shared widely to receive feedback and evaluation through various channels, including further workshops, academic papers, symposiums, talks, exhibitions, and direct discussion with synaesthesia experts.

While this research examines the differences between previous synaesthesia application research and current PhD synaesthesia research in a design context, this research journey progresses to answer two questions (see below) via a practice-based methodology. The two research questions were generated by various personal motivations as well as by the inspiring quality of synaesthesia (see chapter 2: Foundation & Motivation). Throughout this thesis, I have included a number of personal observations, which I argue are justified in the context of this work because of my personal motivations for the research (section 2.1) and the influence of anxiety on my work (section 4.3) and the overall constructivist, phenomenological approach to a subject which is dependent on personal experience (sections 4.1 and 4.2).

While current scientific research on the topic of synaesthesia has begun to inquire further potential applications beyond the scientific analysis of synaesthesia, the lack of debates on synaesthesia application within the field of design has also encouraged me to generate two research questions (Haverkamp, 2013, p.9; Beresford, 2014).

RESEARCH QUESTIONS

[RQ1] How can the characteristics / properties of synaesthesia be used / applied to stimulate creative idea generation and debate?

[RQ2] What tools can be created to support these approaches / applications?

The two research questions will be referred to as **[RQ1]** and **[RQ2]** in relation to the research findings, projects and contribution to knowledge.

This PhD research aims that the audience will learn about synaesthesia research in the context of design study, and be motivated by the inspiring properties of synaesthesia and its methods of application. It is my sincere wish that this research facilitates and inspires future research that links to the subject of synaesthesia in relation to design research. Synaesthesia is one of the rare subjects where both scientific analysis and creative interpretation intersect. By researching and exploring this intersection, valuable insights may inform and enrich the interdisciplinary design research culture.

STRUCTURE OF THE THESIS

This PhD thesis consists of seven chapters.

Chapter 1 introduces the objectives of this PhD research, including the key research questions and the overall format of this PhD structure.

Chapter 2 explains of my motivations for this PhD research by discussing various projects I have designed. This chapter presents how I have developed my interest to explore the subject of synaesthesia and its provocative quality in relation to this design PhD research.

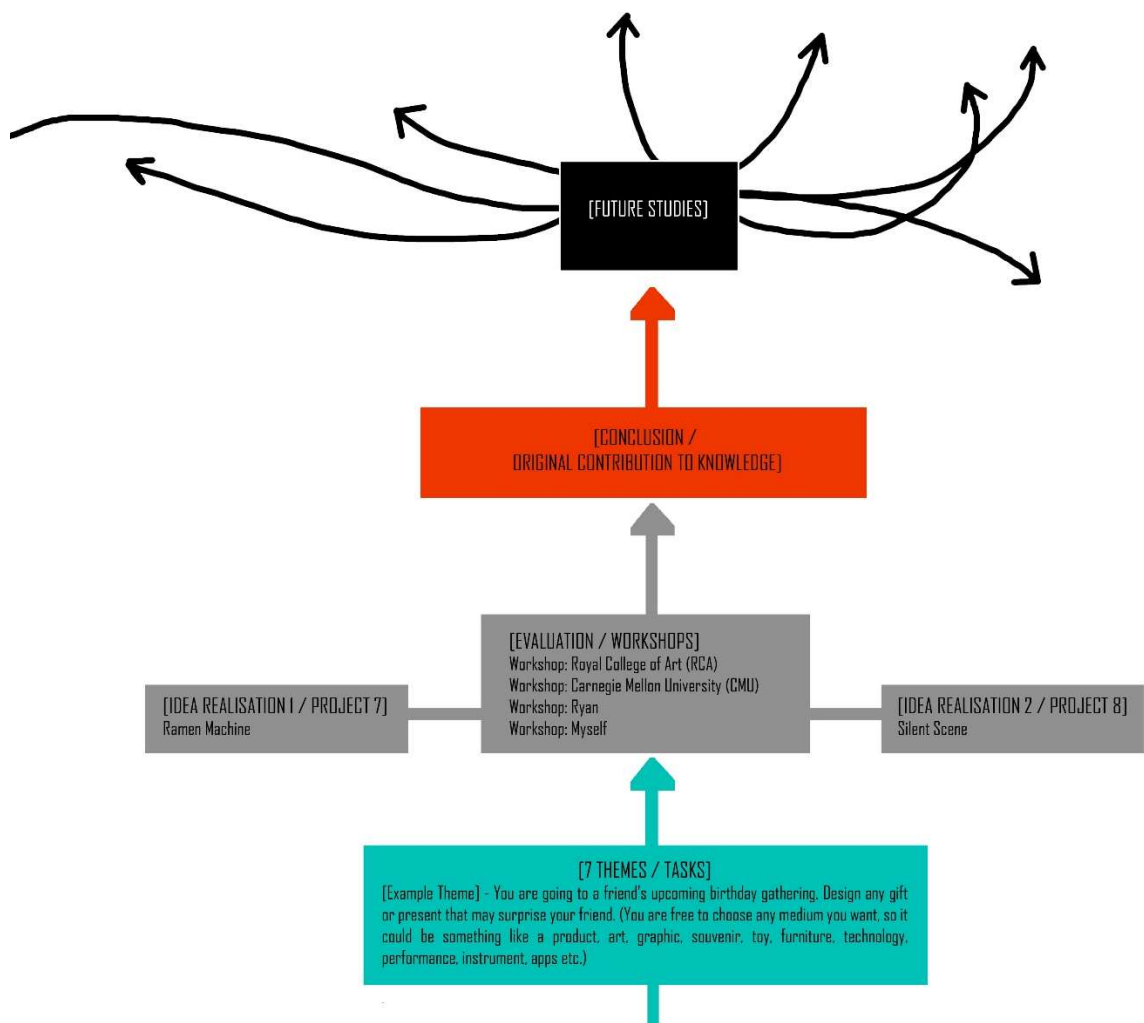
Chapter 3 reviews the current literature and creative practices within the realm of synaesthesia research and provides the reader with the necessary background knowledge and context of this PhD research. The review will begin by trying to understand the landscape of synaesthesia research, mainly as it has been conducted within the field of science. Then, it will consider synaesthesia research in design to see how the field of design has taken the subject of synaesthesia thus far. These reviews will identify a 'knowledge gap'.

Chapter 4 shares the methodology, approaches and mindset of this PhD research. It describes the epistemological stance and perspectives used in this PhD research, and the interdisciplinary nature of synaesthesia research. It outlines how practice-based research and creative practices are employed and framed within this research, then presents methods used to analyze and validate findings.

Chapter 5 shares the identification of three properties, or characteristics, of synaesthesia through design practices in a creative context. These properties compose one of main outcomes of this research that inform the synaesthetic-provocation toolkit, outlined here. This chapter will then introduce workshop processes, development of the toolkit and expert feedback in relation to the research findings. It concludes by relating these findings to research questions [RQ1] and [RQ2].

Chapter 6 discusses the research findings through the research questions by understanding previous chapters. This chapter also suggests various fields that are relevant to this PhD research and concerns for future studies.

Chapter 7 describes the original contributions to knowledge and its influences.



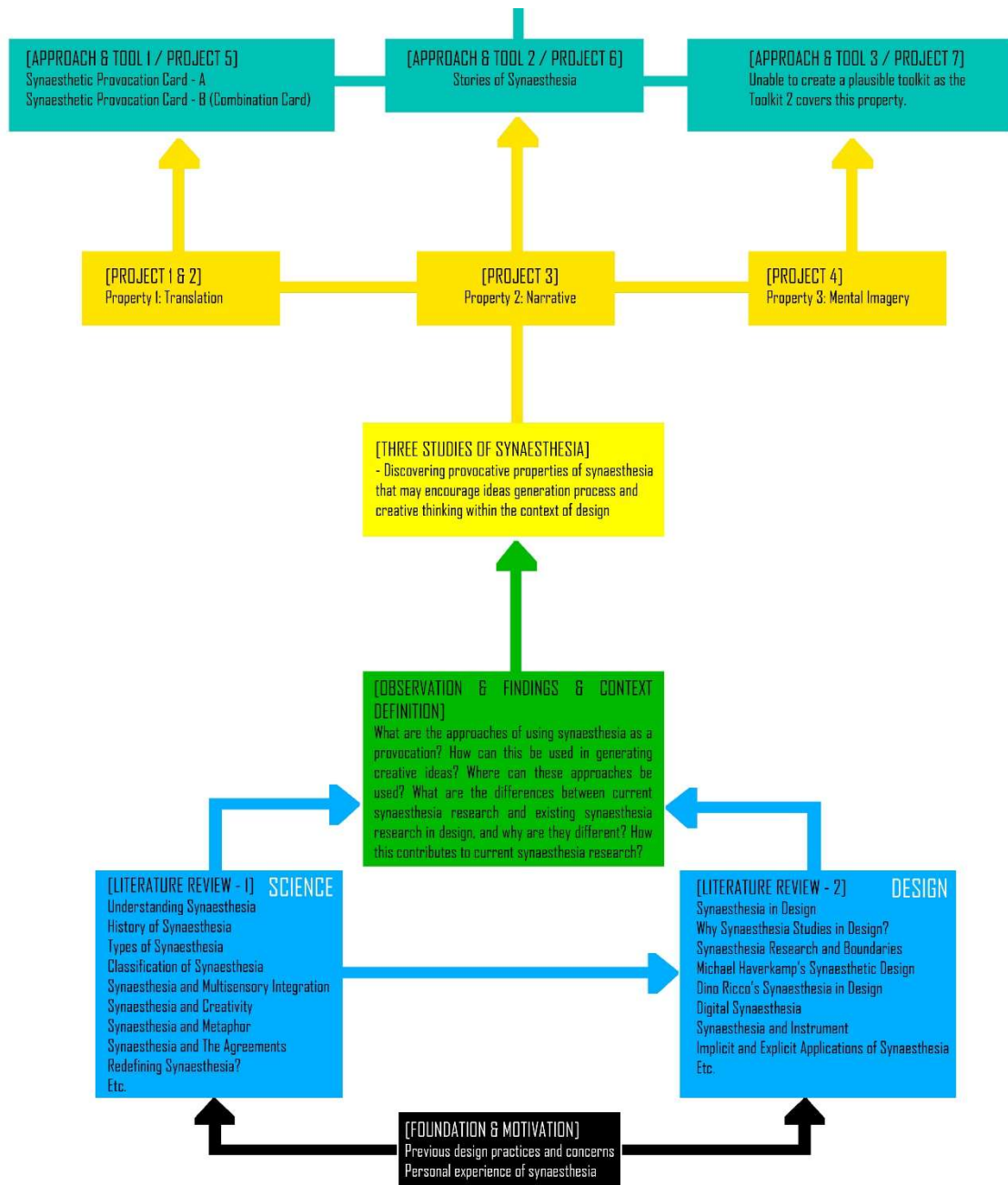


Figure.1 PhD Structure Diagram

2. FOUNDATION & MOTIVATION

This chapter articulates the key motivations and past experiences that led me to investigate this subject by practice, and how they have contributed in shaping my research direction and perspective. Interpreting this personal journey of what motivated my thoughts aims to be useful to readers, for an enhanced understanding of this research by practice in design.

2.1: Foundation & Motivation 1: Synaesthetic Experience

2.2: Foundation & Motivation 2: Materialising Intangible Quality

2.3: Foundation & Motivation 3: Sound to Smell

2.4: Foundation & Motivation 4: Opportunity

2.1: Foundation & Motivation 1: Synaesthetic Experience



Figure.2 Memory of Seaweed

I still clearly remember the day when I talked to my mother about the taste of seaweed ¹, telling her that the taste of a seaweed sheet (fig.2) is rather unusual, tasting like “cracked fluorescent purple” after it has been stored in the fridge for a long time. hilariously, my mother, who was a middle school art teacher ², responded, “the taste of seaweed is purple, but not cracked fluorescent purple!” This type of exchange was not a particularly surprising thing at that time when I was about seven years old. I thought this was a typical daily sensation that everyone experienced. Besides, we also often used to communicate using non-existent verbal language, vocabularies or even sounds to deliver explicitly and precisely each other’s particular emotion, feeling and expressing our own. We never talked or behaved to each other like that when someone else was near; it was a very special channel that I shared with my mother for total communication. The seaweed case was just one of the hundreds of similar memories.

For a long time, long before I began this research, this form of experience and memory always implicitly invited me to consider various subjects such as fine art, cartoon, psychology, magic, mythology and ancient architecture. This was probably because I did not know there was a term called synaesthesia, but I tacitly thought this sort of experience and phenomenon somehow related to some of those subjects. This accumulated data, curiosity, fascination and tacit knowledge later became a foundation and creative pool of my research, and directed me to question and explore the provocative qualities of synaesthesia and its potential implementations within the context of design.

¹ Seaweed is a common food in East Asia. It is typically eaten by putting a small amount of rice and other ingredients (depending on the person’s preference) on a sheet of seaweed (fig.1) and rolling them into one piece before eating.

² I was highly influenced by my mother, who was a middle school art teacher, when I grew up as a child. Her interest in interior architect, drawing, and, particularly, her empathic and sincere way of communication inspired my creative or inventive mind as a child. I have clear images of those memories and layout of that spatial experience.

2.2: Foundation & Motivation 2: Materialising Intangible Quality

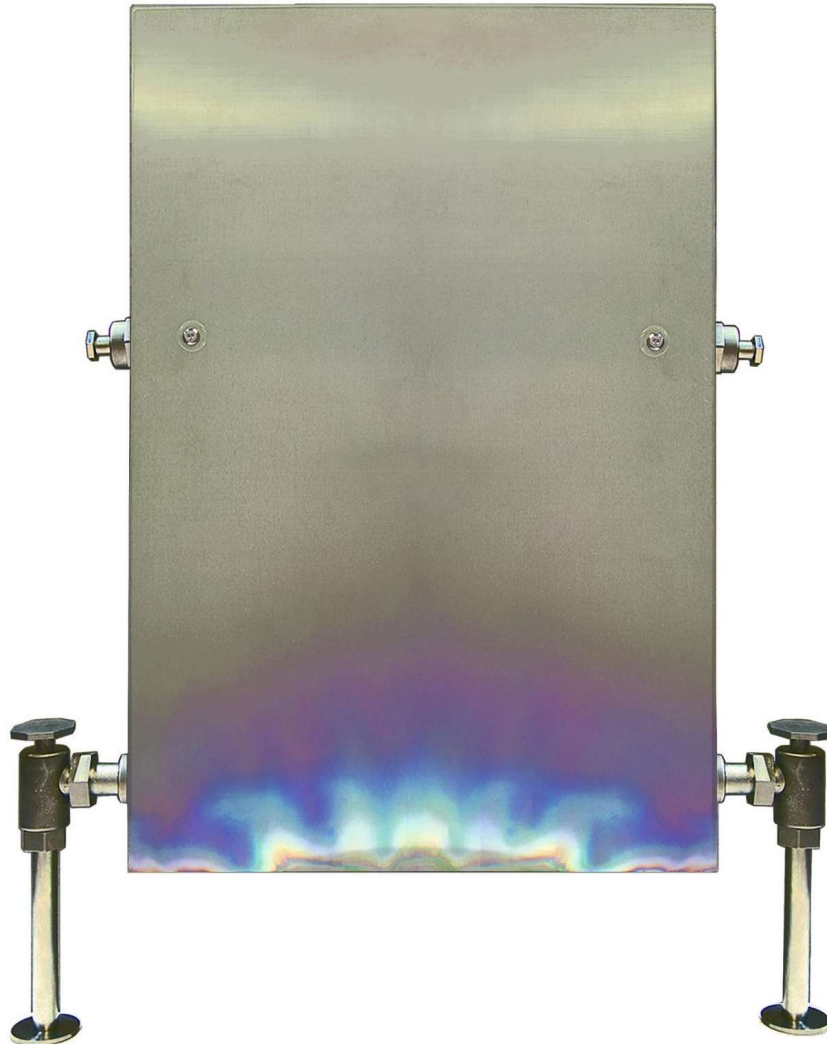


Figure.3 Nova

I studied Industrial Design for my first degree and was deeply fascinated in shaping, combining and experimenting using different types of material and the different functions of products ³. *Nova* (fig.3) was a radiator-heating unit that I created for my graduation show during my undergraduate study at the Central Academy of Fine Arts, Beijing. It was a radiator-heating unit, mostly built from titanium and aluminum. It was a

³ I gave much thought about whether to study painting or Sculpture, but later changed my mind and opted to study design, which I considered a more practical art for everyone during that time.

design intended to manifest a function of heat and to visualize the concept of intangible energy. The surface of the heater would constantly interact with the growing heat from the bottom, and it would accumulate and record itself with the natural pattern of the expanding heat on the outer surface of the heater. The colour of the growing pattern is naturally formed by the increased heat interacting with the material. As such, it was an attempt to articulate the concept of heat or energy visually. The process of creating this early work strongly triggered my interest in exploring and materialising intangible properties, and later inspired my other works, which furthered my interest in investigating the intangible qualities that affect our environment and us.

2.3: Foundation & Motivation 3: Sound to Smell



Figure.4 Essence in Space

After finishing my undergraduate study, I wanted to learn and expand my view of industrial design to view the outside world. Thus, I moved to London, which I considered the creative hub of the world, for my postgraduate studies.

Essence in Space was (fig.4) was a graduation project in which I tried to embrace the subject of synaesthesia in a design context. I made the work during my master's studies in Design Critical Practice at Goldsmiths, University of London, which I took prior to this PhD.



Figure.5 Bottle of Music

Essence in Space is realized through an adapted keyboard that transforms sound and fragrance into a unique perfume. Each key (lower sounds created woody and floral scents and higher sounds were connected to fresh and watery scents) is mechanically linked to a type of fragrance, located below the keyboard ⁴. As each key is pressed, another part is lifted up and, in so doing, air is then released into a tube. Once the air enters the tube, the

⁴ I was deeply fascinated in by the mechanical aspects of making and construction while studying Industrial Design during my first degree at the Central Academy of Fine Arts. Project *Essence in Space* reveals my interest in this area and this interest which later developed further interest into electronics and mechatronics, which led me, in my spare time during my PhD, to self-study things like Atmel AVR ATmega328, 555 Timer IC, Arduino, ATtiny85 and different logic gates.

lower section of the instrument releases a droplet of perfume. This droplet of perfume is then collected in a bottle. This process continues as each key is struck, thereby creating a mixture of different perfume droplets in the bottle. At the end of the 'performance', a unique blend of perfume droplets has been created (fig.5).

Essence in Space was mainly inspired by the topic of synaesthesia and the project attempted to transform a medium (music) to another medium (scent). What if taste becomes motion? What if shape becomes sound? Synaesthesia is a personal experience, so how can we translate one's very personal experience into a creative practice? How can design research and practice embrace this understanding in design study? What can design learn by exploring this area of research? The mapping between two different experiences or phenomenon fed and encouraged my fundamental interest in this subject. The research on the topic of synaesthesia, scents and sounds that I conducted throughout this earlier project was one of the defining influences that made me choose, question and explore the topic of synaesthesia and its opportunities for my practice-based design PhD.

2.4: Foundation & Motivation 4: Opportunity



Figure.6 Touch Art Fair 2013: Chapman Brother's Artwork and Visually Impaired Children

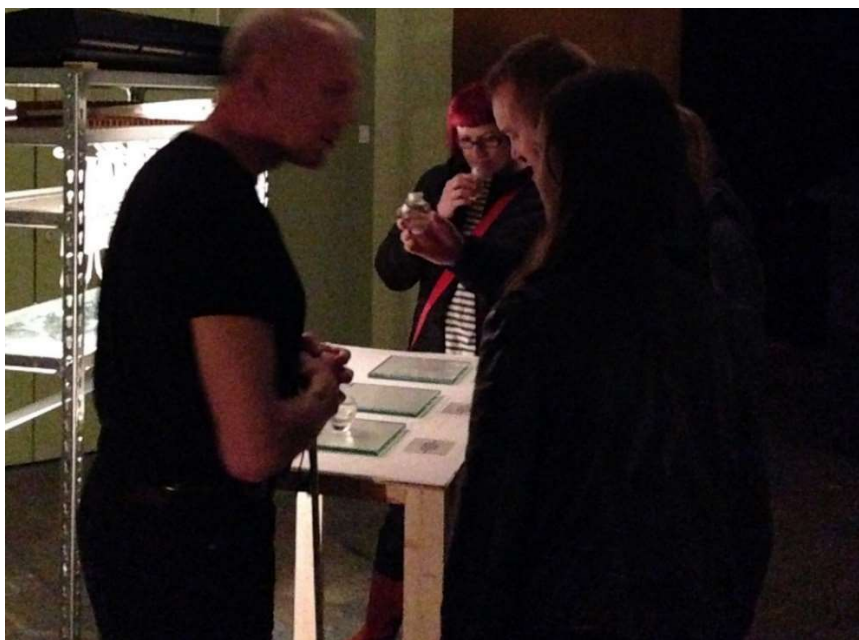


Figure.7 Touch Art Fair 2013: Essence in Space with Sight & Hearing Loss People

During an exhibition at Hoxton Gallery in London, I was able to meet a curator who offered me an unusual opportunity: he asked me to exhibit my work (*Essence in Space*) together with the internationally renowned artists Jake and Dinos Chapman (Chapman Brothers) and a few other artists. The exhibition was called The Touch Art Fair and was held during the Frieze week in 2013; it had an innovative mindset toward the concept of the exhibition, and attempted to make art accessible to impaired people through touching the actual art works through sensory experience (fig 6 & 7). During the exhibition, visitors with both hearing and sight loss were able to appreciate a ‘translation’ of the music by using their nose to smell the bottle of music (fig 5 & 7). Viewing this delightful communication from far away, I became deeply fascinated by the potential of sensory substitution and its provocative qualities in a design context. This direct engagement and my interactions with sensory-impaired people inspired my thoughts and led me to question various aspects of the potential of exploring synaesthesia in relation to design research. This then fed the foundational knowledge of this study, and unlocked very rudimentary questions at its beginning, such as “what can we achieve through exploring the idea of synaesthesia, and what is the potential of synaesthesia application in design?” My exploration on this topic began from then.

3. LITERATURE & PRACTICE REVIEW

This chapter will present the most relevant literature that underpins the topic of this research. This literature led this research to consider a new opportunity in synaesthesia application in design; particularly, it enabled this research to observe critically the potential of the provocative properties of synaesthesia as an inspirational tool in design study. This chapter will attempt to outline this background research from the historical, scientific and creative point of view as a designer. Viewing this background research context will be useful for readers who want to understand the overall concerns regarding the topic of this research.

3.1: Understanding Synaesthesia

3.1.1: Classification of Synaesthesia

3.1.2: Types of Synaesthesia

3.1.3: Synaesthesia and Multisensory Integration

3.1.4: Synaesthesia and Metaphor

3.1.5: Synaesthesia and The Agreements

3.1.6: Synaesthesia and Creativity

3.1.7: Redefining Synaesthesia?

3.1.8: Summary & What I Learned

3.2: Synaesthesia in Design

3.2.1: Why Synaesthesia Studies in Design?

3.2.2: Synaesthesia Research and Boundaries

3.2.3: Synaesthetic Inputs in Different Contexts

3.2.4: Implicit Applications of Synaesthesia

3.2.5: Explicit Applications of Synaesthesia

3.2.6: Synaesthetic Design

3.2.7: Digital Synaesthesia

3.2.8: Summary & What I learned

3.1: Understanding Synaesthesia

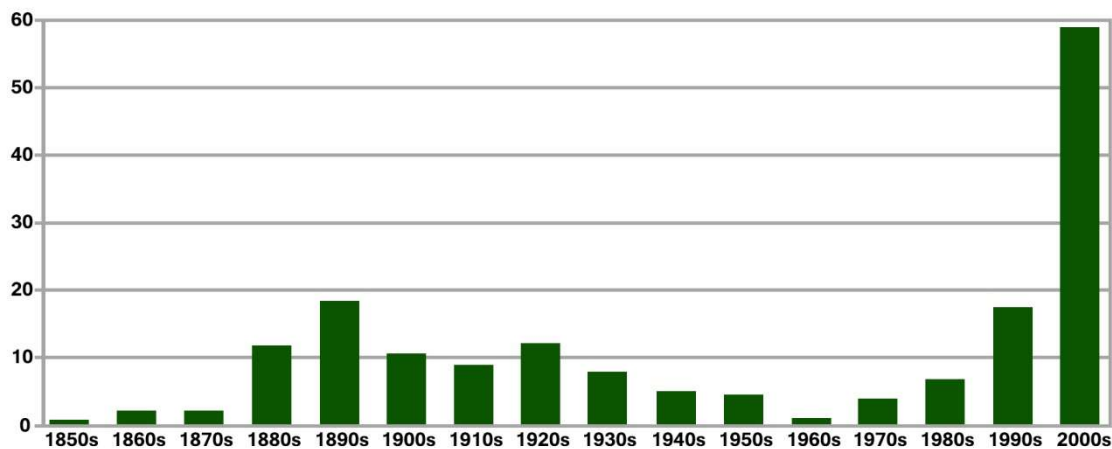


Figure.8 Number of Academic Articles on Synaesthesia: Adapted and re-illustrated from (Cytowic and Eagleman, 2009, p.16)

The word ‘synaesthesia’ is not regularly used in everyday life. Indeed, most people have probably never even heard of it. As such, it seems worthwhile to consider the origin of the term briefly. The word synaesthesia is derived from the Greek “syn”, which means union, and “aesthesia”, which means sensation; the two words together become synaesthesia, a “union of the sensation” (Harrison, 2001, pp.3-4). It is a very broad term that describes and covers vastly different concepts and events. It is used to denote an unusual sensation and neurological condition, such as music that is not just heard but also tasted or even felt as a physical touch (Cytowic and Eagleman, 2009). We can see this idea more clearly in the following example.

“I heard the bell ringing... a small, round object rolled before my eyes... my fingers sensed something rough like a rope... I experienced a taste of salt water... and something white.” (Ibid.)

Synaesthesia has long been a captivating source for a range of topics in a variety of disciplines. Its transcendental and intangible quality invites speculative thoughts and romantic aspirations (Dann, 1998, p.x). The root of synaesthesia may date back more than a thousand years, when ancient scholars like Aristotle emphasised different arrangements of specific metaphorical characters such as “clear sound” and “harsh

sound”, which perhaps provides a distant origin of our modern understanding of the term (Cordoba, Riccò and Day, 2014, p.220).



Figure.9 A Caricature of Louis-Bertrand Castel's "Ocular Organ" by Charles Germain Aubin in the eighteenth century

Many contemporary sources (Butler and Purves, 2014; Dann, 1998; Olson, 1983) consider that interest in synaesthesia existed in the seventeenth or eighteenth century because during that period people started to speculate about the complex network of human sensations. For instance, in the middle of the eighteenth century, mathematician Louis Bertrand Castel tried to design an instrument (fig.9) that could produce coloured lights that harmonised with musical notes (Franssen, 1991, p.20; Dann, 1998, p.9). Furthermore, during the seventeenth century, the philosopher John Locke was one among several who incorporated written synaesthetic related expressions in their literature. Locke referred to a blind man who “bragged one day that he now understood what scarlet was.. like the sound of a trumpet” (Locke, 1690; Simner, et al., 2013). However, during that time, people were not concerned or aware that these types of

speculations may be considered as relevant concepts of synaesthesia (Dann, 1998, p.9).

Synaesthesia was first introduced to the field of psychology more than one hundred and fifty years ago, and the concept has been theorised by some of the most famous psychologists in North America and Europe for more than a century (Dann, 1998, pp.5-6). However, its intangible and transcendental characteristics remained obscure until very recently as there was still no widely accepted scientific mechanism of synaesthesia, although psychological research had accumulated extensive descriptions and text for synaesthesia diagnosis (Ibid.). From the 1880s to the 1920s, synaesthesia research dramatically increased (fig.8), but this was followed by a marked decline for several decades, largely because of the immeasurable quality of synaesthesia. However, there were a mass of young scientists who were unafraid to challenge orthodoxy, and technological innovation in neuroscience provided groundbreaking methods (such as fMRI brain scanning and neuroimaging) in the 2000s, which enabled researchers to identify this subjective phenomenon objectively (Harrison, 2001, pp.141-147). These developments allowed research into this field to surge (Cytowic and Eagleman, 2009, p.15).

Modern neuroscience was still quite young and lacked much in the way of reliable scientific evidence until this technological innovation. The well-known psychologist and neurologist Simon Baron-Cohen mentioned in his colleague's book *Synaesthesia the Strangest Thing* that the topic of synaesthesia was a very controversial and arcane choice to investigate even in the 1990s. He stated that the majority of scientists did not take the topic seriously for scientific understanding because the scientific evidence was still very thin (Harrison, 2001, p.vii). Richard Cytowic, a pioneering synaesthesia researcher, neurologist and the author of the popular 1993 book *The Man Who Tasted Shapes*, has also claimed that some scientists were quite sceptical about the topic and had lost interest in synaesthesia because of the difficulty in proving and explicitly explaining a person's subjective experience (a third-person verification of a subjective first-person experience). As such, it had been dismissed as mere overactive imagination or hallucination for a long time (Cytowic and Eagleman, 2009, p.4).

When we consider that only about two decades have passed since modern neuroscience was scientifically able to prove the existence of synaesthesia, we realise that there must be an enormous reservoir of untapped potential waiting to be discovered and applied in various fields including the field of design. At present, the research on the topic of synaesthesia has been largely dominated by science (mainly encompassing the field of psychology and cognitive neuroscience), with synaesthesia researchers coming from a range of different scientific backgrounds, examining and defining the causes and conditions of synaesthesia from different angles. However, their research has been largely uncultivated beyond the mere research analysis. Consequently, there has been significantly less research undertaken regarding its application and usefulness in terms of how we may benefit from synaesthesia (Beresford, 2014; Charles, 2012). Historically, synaesthesia research is experiencing a renaissance period (Cytowic and Eagleman, 2009, p.16). These issues make it an ideal time to look more closely into its creative approaches and development.

3.1.1: Classification of Synaesthesia

Synaesthesia researchers are trying to identify classes of synaesthesia in order to understand precisely which condition and status people are referring. According to Aleksandra Rogowska (2011), Simon Baron-Cohen and John Harrison (1997) there seem to be four different categories of synaesthesia. They are developmental synaesthesia, neurological dysfunction synaesthesia (acquired synaesthesia), metaphorical synaesthesia and drug-induced synaesthesia (temporary synaesthesia) (Duffy, 2001, pp. 42-50) (fig.10).

Developmental synaesthesia	Occurs in early childhood and seems to reveal a stage of development of brain and cognitive process.
Acquired synaesthesia	Occurs in adulthood, on result nervous system damage, and seems to compensate some cognitive dysfunctions.
Temporary synaesthesia	Influenced by external influences such as by drugs (such as lysergic acid diethylamide or hashish). This is possible most likely by using intermodal links, which concern sensory

	integration process.
Synaesthetic metaphors	While there is not total congruency between synaesthesia and synaesthetic metaphors, they do overlap significantly in their focus on hearing (such as for most of us, high pitch of sound associate to brighter colour and low pitch of sound links to darker colour).

Figure.10 Categorisation of Synaesthesia

Firstly (fig.10), developmental synaesthesia appears to begin during the early stages of childhood, before the age of four. It occurs naturally, being innate rather than learned phenomena. Developmental synaesthetes' synaesthetic perceptions are mostly clear and vivid (Duffy, 2001). In contrast, neurological dysfunction synaesthesia can be acquired by physical changes such as a head injury. However, its performance is relatively inconsistent compared to the innate classes. Perhaps a classic example of neurological dysfunctional synaesthesia is the case of blindness. Some blind people experience sound-colour or touch-colour synaesthesia after they lose their eyesight (Niccolai, Leeuwen and Blakemore, 2002). Synaesthetic metaphors and synaesthesia have many overlapping elements, particularly in their focus on hearing. (I will discuss this separately in section 3.1.4: Synaesthesia and Metaphor). Lastly, temporary synaesthesia or drug-induced synaesthesia, as the name implies, can be experienced by consuming psychoactive drugs such as LSD (lysergic acid diethylamide) or hashish. This artificial synaesthesia disappears as soon as the effect of the drug wears off. It is a temporary phenomenon and lacks consistency compared to constitutional or innate synaesthesia; for example, in artificial synaesthesia, the smell of ceramic might be experienced as yellow but dark blue soon afterward (Baron-Cohen and Harrison, 1997).



Figure.11 Conceivable Example of Projector Synaesthete (Gill, 2009)

Another classification relates to the two dissimilar perceiving abilities of a synaesthete. They have been classified into two different dimensions by various researchers such as Ramachandran, Dixon, Smilek, Sean A Day and others (Gebuis, Nijboer and Smagt, 2009, pp. 1704-1709). The two different dimensions are not about different types of synaesthesia, nor individuals' understanding of their subjective colourful world. It is about two methods of experiencing synaesthesia - distinguished as being either an associator synaesthete or a projector synaesthete. Associator synaesthetes are those who perceive their photism internally in their mind's eye, and this is the type experienced by the majority of synaesthetes. By contrast, people who experience projector synaesthesia (fig.11) can actually see and screen their photism externally in the outside the world, and this becomes their perceptual reality (Dixon, Smilek and Merikle, 2004). This phenomenon is astonishing to the person experiencing it as it is associated with a completely different texture of the world. It is a kind of narrative that could only be seen in a fantasy or science fiction movie; it is potentially a provocation and valuable source to investigate in relation to synaesthesia accessibility within the context of design.

3.1.2: Types of Synaesthesia

Type	Frequency (%)
Graphemes -> Colours	66.50
Time Units -> Colours	22.80
Musical Sounds -> Colours	18.50
General Sounds -> Colours	14.50
Phonemes -> Colours	9.90
Musical Notes -> Colours	9.60
Smells -> Colours	6.80
Tastes -> Colours	6.60
Sound -> Tastes	6.20
Pain -> Colours	5.80
Personalities -> Colours	5.50
Touch -> Colours	4.00
Sound -> Touch	4.00
Temperatures -> Colours	2.40
Vision -> Tastes	2.10
Sounds -> Smells	1.80
Vision -> Sounds	1.50
Orgasm -> Colours	1.00
Emotions -> Colours	1.00
Vision -> Smells	1.00
Vision -> Touch	1.00
Smells -> Touch	0.60
Touch -> Tastes	0.60
Smells -> Sounds	0.50
Sounds -> Kinetics	0.50
Sound -> Temperatures	0.50
Tastes -> Touch	0.50
Kinetics -> Sounds	0.40
Personalities -> Smells	0.40
Touch -> Sounds	0.40
Touch -> Smell	0.30
Vision -> Temperatures	0.30
Musical Notes -> Tastes	0.10
Personalities -> Touch	0.10
Smells -> Tastes	0.10
Smells -> Temperatures	0.10
Tastes -> Sounds	0.10
Tastes -> Temperatures	0.10
Temperatures -> Sounds	0.10

Figure.12 Types of Synaesthesia (Cytowic and Eagleman, 2009, p.25)

Originally Compiled by Sean A Day (2008)

There are at least eighty different types of synaesthesia, from hearing colours to tasting temperature (Day, 2016). Figure 12 lists the relative frequency of the different types of synaesthesia. Its types are increasing as people become more aware and share their experiences. Many scientists rely on the reports by some conscious synaesthetes, but not all synaesthetes share their different texture of reality. Most synaesthetes normally become aware of their unique experience at an early age, about five or six years old, when having social interactions with their family. These interactions make them aware that they perceive differently from others. Once they have experienced their first unexpected, sudden encounter, they start to give more attention to their behaviour. Some adult synaesthetes report to experts about their synaesthetic perception of their environment (Campen, 2007).

With the growing number of academic publications (Fig.8) and increased media attention, people's awareness of synaesthesia has grown significantly in the last few decades. This attention has brought somewhat of a flexible domain and environment that allows synaesthetes to report their unusual issues easily. With the growing number of reports of synaesthetic experience, the estimated occurrence of synaesthesia has also changed tremendously. For instance, in the middle of the 1990s, the prevalence of coloured-letter synaesthesia was one in two thousand (Baron-Cohen et al. 1996). However, this rate has increased to one in two hundred, which shows the reported occurrence is ten times more than a half-decade ago (Ramachandran and Hubbard, 2001). The percentage also varies depending on the type of synaesthesia (Day, 2016, p.23). New types of synaesthesia are also constantly appearing with the growth of synaesthesia reports by individuals. For instance, the most recently discovered synaesthesia could be mirror-touch synaesthesia. Mirror-touch synaesthesia⁵ is one of the rarest types of synaesthesia; watching another person being touched may trigger a similar neural circuit to a viewer and can generate a tactile sensation on their own body (Banissy and Ward, 2007). All these intriguing properties and types of synaesthesia are potential sources for informing original and exciting design provocations. The opportunity for speculation regarding the different

⁵ Mirror-touch *synaesthesia* symposium at *Tate Modern* in 2014: <http://www.tate.org.uk/context-comment/video/mirror-touch-synaesthesia-social-video-recording>

types of synaesthesia will be covered more in Chapter 5.0: Design Studies.

3.1.3: Synaesthesia and Multisensory Intergration

There are significant differences between synaesthesia and multisensory integration, however many people (artists, designers, engineers, architects, scientists etc.) new to the topic of synaesthesia fail to grasp the differences between the two. I have frequently received questions regarding the difference and boundary between the two subjects in my synaesthesia research; thus, I will briefly cover some of the literature regarding the major differences before moving on to discuss the relationship and connection between synaesthesia and metaphor in the next chapter.

According to Ward (2011), a pioneering neurologist and synaesthesia researcher, one of the things that both topics of synaesthesia and multisensory integration brings to us is that all of our senses are not completely separate from one another, and all of us have the capability to connect these different senses.

For instance, in all of our multisensory perceptions, looking at a person's lips while having a conversation may potentially amplify the response properties of neurons just by combining the two different inputs (hearing and visual inputs). Multisensory integration combines any sensory inputs that happened at the same time and makes a sense and model in our brain, regardless of whether or not they are related. In contrast, in the case of synaesthesia, only one sense is stimulated (for instance, hearing) and the brain involuntary converts this information to another sense and creates an entirely new sensation, such as smell, which is quite different compared with typical multisensory perceptions.

To conclude, while in all of our multisensory perceptions different information channels are being stimulated together at the same time, and our brains combine them to make sense of the world, synaesthesia creates a whole new percept from just a single sensory stimulation (Ward, 2011).

3.1.4: Synaesthesia and Metaphor

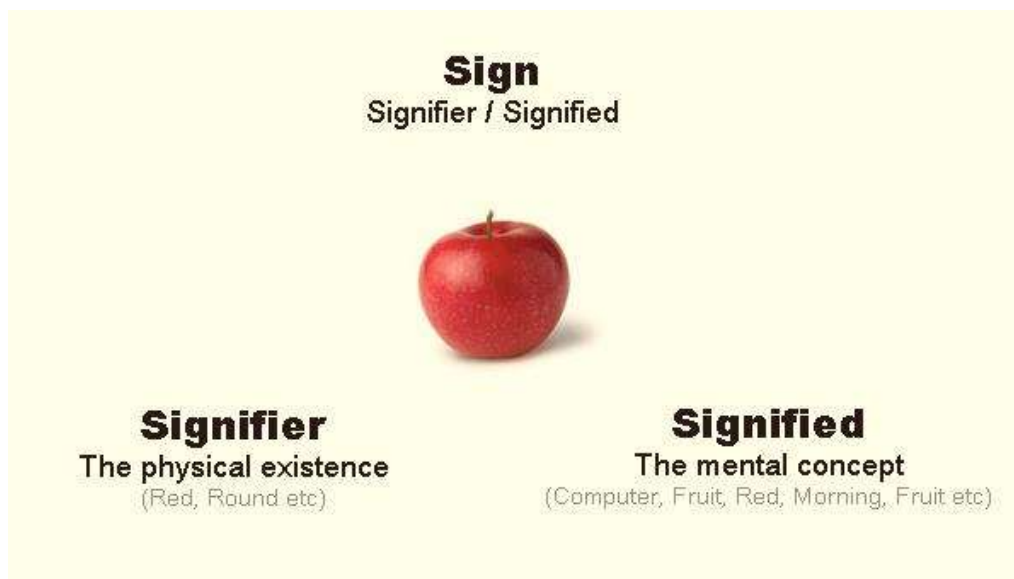


Figure.13 Sign = Signified / Signifier (Saussure, 1959, p.67; Harvey, 2014)

It is difficult to exclude the idea of metaphor in synaesthesia research, as there are many shared features and intersections between the two subjects. A few examples of this are synaesthetic metaphors such as “sweet smell”, “dark sound” and “loud colours” (Day, 1996). Why are we using such expressions for our communication? Is synaesthesia just another concept or form of metaphor? Vilayanur Ramachandran (Ramachandran and Hubbard, 2001a; Ramachandran and Hubbard, 2001b; Neuroanthropology, 2008) pointed out several differences between the two subjects. Briefly put, as I will mention more in a later chapter (see section 3.1.7: Redefining Synaesthesia?), synaesthetic associations are, firstly, stable. Secondly, synaesthetic associations are involuntary. Thirdly, synaesthetic associations are unidirectional. Finally, Ramachandran claims that synaesthesia is a perception effect, not a memory association, a symbolic link or an analogy. Most importantly, the major difference regarding the two relationships is that in order for metaphors to communicate meanings, there must be a certain degree of common agreement between communicators (Marks, 1978). Nevertheless, synaesthesia is a highly subjective phenomenon outside of common agreement; thus, the function of the two subjects may be fundamentally different.

There are two paths to the history of theories relating to synaesthesia. The first follows theories of a complex network of metaphor, implication and association, which are more related to its psychological aspects. The second, the scientific approaches, which I explained earlier in this writing, was settled much later, after the technological innovation. This is the neurological and physical approach to synaesthesia (Day, 1996). As I pointed out at the beginning of this writing, metaphorical and semantic forms of language could be the possible origin of synaesthesia. However, the crucial problem of metaphor justification is that it makes one of the conventional mistakes in science, which is that it tries to explain one major mystery in science (metaphor) with another mystery (synaesthesia) (Ramachandran and Hubbard, 2001, p.4). As science knows very little about metaphor, this will not help explaining either one of them. In Ramachandran's talk at the World Science Festival in 2008, he suggests that even though there may be some metaphors such as synaesthesia, the metaphor is just expedient shorthand for explaining the complicated network of cognitive phenomena. He doubts and supposes that there must be a deep relationship such as genetic aspects (Neuroanthropology, 2008). The topic of metaphor is scientifically unclear and the question of dealing with metaphor in scientific theories is perhaps "as old as the philosophy of science itself" (Darmstadt, 2007, p.7). Therefore, it seems that exploring for congruency of two scientifically yet fully discovered topics needs to be handled prudently. However, it could be argued that the scientific difficulties of clearly bridging two mysterious aspects have rather inspired and broadened our scopes and knowledge of synaesthesia.

There have been a relatively high number of research papers that consider the differences between the two subjects, but relatively few that attempt to articulate the similar or shared traits. There are, no doubt, many reasons for this, but one of the reasons may be that the realm of metaphor in relation to synaesthesia within science is an elusively complex topic (Cordoba, 2013, p.183). One of the particular traits that appear similar is that both synaesthesia and metaphor stand for something. For example, in the case of grapheme-colour synaesthesia, alphabet "A" could stand for colour red and in metaphor, alphabet "A" may also stand for something such as a grading system or any other metaphorical representation. This means they both employ the concept of a "sign". Any sign (fig.13) must have both a signifier (e.g. the form of an apple) and a signified (e.g. the

concept the form of the apple represents) as the two always function together (Saussure, 1959, p.67). This idea of the “sign” can be closely linked to the concept of semiotics in design (Hjelm, 2002, pp.i-25)⁶. One of the main approaches of semiotics in design is the discussion of the correct ways to design things so they can be used and interpreted easily, which tacitly suggests the need to look into some of the “common agreements” regarding the idea of synaesthetic perception within the context of design. Although neurologist Richard Cytowic (1993) has noted that neurological synaesthesia does not associate “common sensibles”, the topic seems worth exploring within design research. This is because the current scientific understanding of synaesthesia is mostly contingent on brain research, where studies largely focus on the organic basis of the experience (Beresford, 2014). Thus, looking into historical cases of artistic experiments may encourage and contribute to synaesthesia research within modern neuroscience (Ione and Tyler, 2004, p.62). Discovering and questioning the provocative qualities of synaesthesia in relation to design is a necessary focus in this paradigm and should be boosted for further progressive conversation within the synaesthesia research community.

By reviewing different perspectives regarding the metaphoric and semantic aspects of synaesthesia through literature, I was able to consider the subject of synaesthesia as an inspirational source in terms of its speculative property. This speculative property allowed me to contemplate the metaphoric and semantic aspects as some of the foundational properties of synaesthesia that make synaesthesia inspiring, which also led me to conduct a project called *Three Studies of Synaesthesia*, for the purpose of studying some of these inspiring properties of synaesthesia from a designer’s perspective (see section 5.1: Three Studies of Synaesthesia). This part of the literature review later influenced the creation of one of the tools within the synaesthetic-provocation toolkit (see section 5.2: Synaesthetic-Provocation Toolkits & section 5.2.3: Synaesthetic Mental Imagery Tool).

⁶ *Mythologies* by Roland Barthes and *Semiotics: The Basics* by Daniel Chandler offer a broad understanding toward the topic of semiotics.

3.1.5: Synaesthesia and the Agreements

Dear Chang,

I received an email from the UK Synesthesia Association about the short stories you need for your project. I'm a word- color synaesthesia type, writer and psychologist. Here is my story:

22 July 1989

Dear Diary,
 Today, after my birthday party for my eight years, I had an argument with my sister. I was saying that Saturday is red and she insisted that is yellow. Suddenly, my mother came into the room and yelled to us: Are you both crazy, young ladies? What red and yellow? Saturday is as blue as the sky is today! I don't know how to tell her to go to a doctor for her eyes...

Wishing all the best for your project.

Kind regards,
 Dimitra Didangelou

Figure.14 Different Experience of Synaesthesia

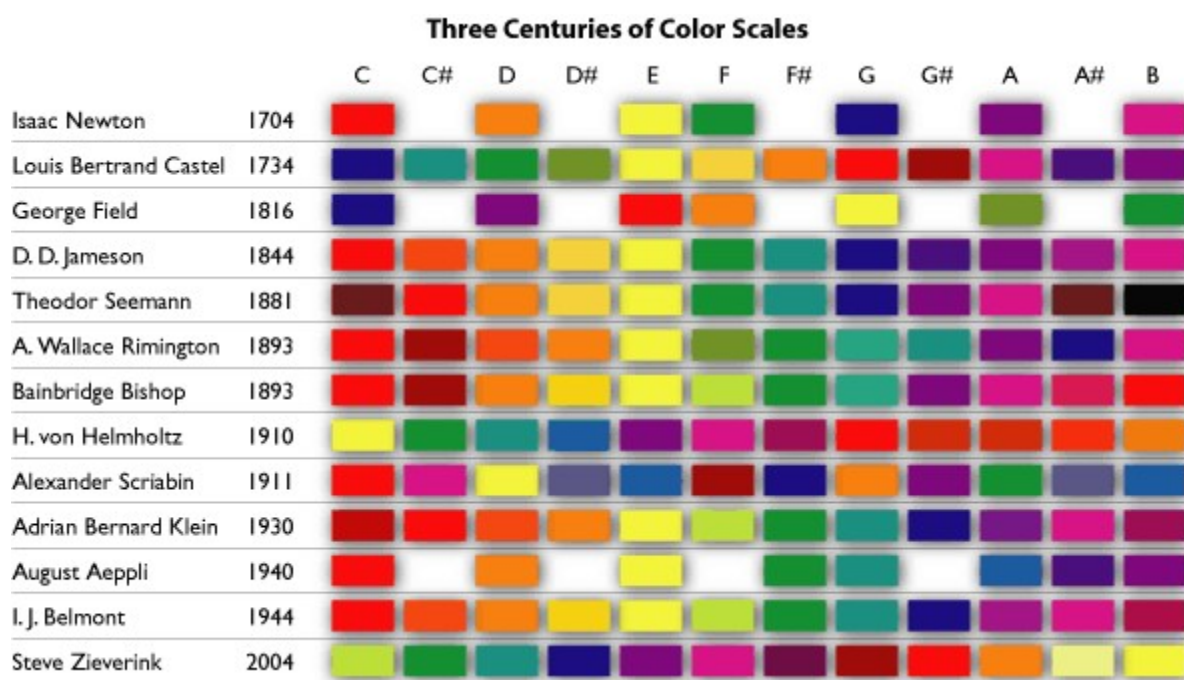


Figure.15 Three Centuries of Color Scales: Originally compiled by Fred Collopy (Brougher, et al., 2005, p.213)

The experience of synaesthesia differs from one individual to another and even between family members including monozygotic twins (Barnett, et al., 2008, pp.882-884). A synaesthesia story (fig.14) that I gathered from a synaesthete through the UKSA (UK Synaesthesia Association) embraces this issue very well. Likewise, subjectivity is one of the peculiar and intriguing traits of synaesthesia. Moreover, these different interpretations exist throughout the history of synaesthesia. A good example of this is the

different colour associations of musical notes (fig.15). In Isaac Newton’s circle of colours, “do” (C) was illustrated as red, but blue in Castel’s and yellow in H. Von Helmholtz’s circle (Ricco, Belluscio, and Guerini, 2003, p.159). However, referring to the luminosity of vocal phonemes, there are remarkable agreements. For instance, most people associate high-pitched sounds to clear and angular images and low-pitched sounds to dark and round images (Gombrich, 1972). This principle is valid in most cases from music, language, and pitches, and these visual correspondence even function outside different cultures (Marks, 1975). Recent psychiatric research by Ludwic (Ludwig, Adachi and Matsuzawa, 2011) found that even chimpanzees favour matching white to high-pitched sound and black to low-pitched sound. This interesting research suggests that a common underlying mechanism of sensory interpretation in primates “seems to be hard-wired rather than acquired through culture or language” (Simner, et al., 2013, p.9)⁷.

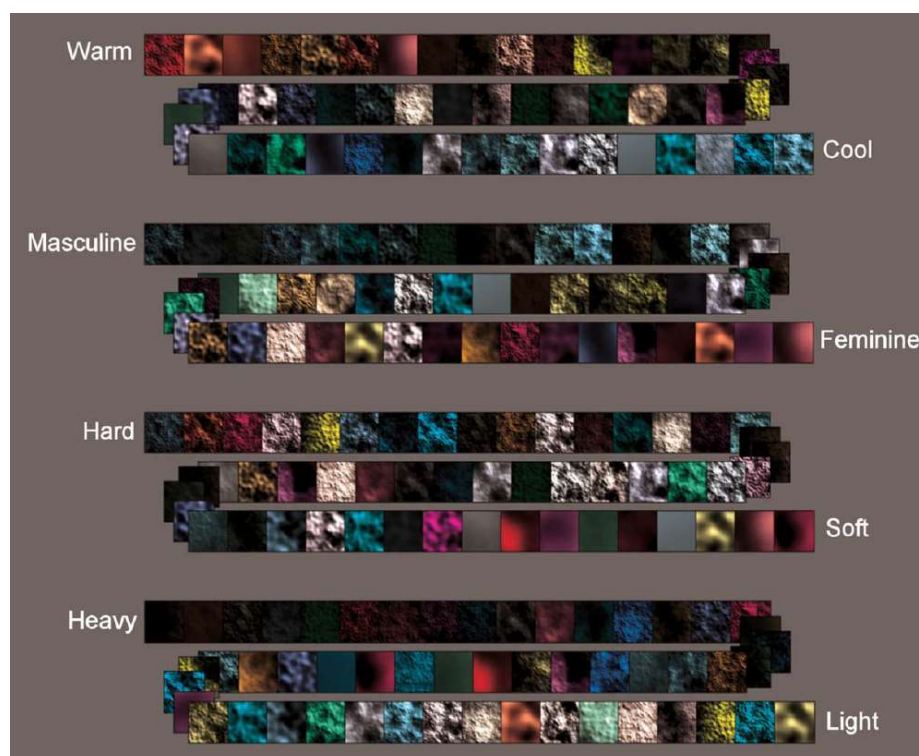


Figure.16 Texture Affects Colour Emotion (Lucassen, Gevers and Gijsenij, 2010, p.436)

⁷ The way chimpanzees take part in cognitive research is interesting to watch (<https://www.youtube.com/watch?v=Dqolmw2ZWml>). This clip shows the amazing memory performance of chimpanzees.

In colour researcher Marcel Lucassen's latest research (Lucassen, Gevers and Gijzen, 2010, pp.426-436), he investigated 25,000 people's responses to how a textured surface can affect colour and emotion. The research allowed the participants to use a computer mouse to drag different samples of texture on the top of a computer screen to test for four emotional scales: heavy-light, feminine-masculine, hard-soft and warm-cool. (The researchers were aware of the fact that one of the characteristics of real texture is that it can change surface perception due to emotional attachments. Thus, they adapted Perlin noise to create synthetic texture, which is a primitive structure used in pseudo-random texture generation, in order to avoid and prevent semantic associations toward texture during the test.) They concluded that a textured surface is closely connected to our psychological responses. Femininity is more associated to pink, red and softer textures, while masculinity was more associated with green, blue and more complex textured surfaces. Cool was linked to blue, while warmth was interpreted as red, brown and perhaps even darker colours. Darker colours were associated with heaviness, while brighter colours were associated with lightness (fig.16). Although this research did not cover the phenomenon of synaesthesia or synaesthete, it later provided a valuable link in Simner's and his colleagues (Simner, et al., 2013, pp.1-11) synaesthesia research regarding synaesthetic colour and visual texture perceptions in relation to different types of "voice quality", such as whisper, nasal and falsetto. In this research, they have found "notably consistent" results where voice-induced synaesthetes (all participants were native speakers of English and had no hearing or sight difficulties) associated higher-pitched sounds with lighter, redder colours and being located, or standing, in a higher position in vertical space, while the whispery voice matches with smoke-like textures. Furthermore, male voices induce larger shapes compared to female voices.

The different research in both perception and synaesthetic perception seems to have an affective connotation or, perhaps, a tacit agreement within our mental images. Thus, in this case, it potentially suggests that Cytowic's (1993) earlier view that "synaesthesia does not associate to common sensible" may be inaccurate. On the other hand, this type of information will likely assist to design our perception and experience modules within the context of design. The implementation of this research in design may range from discovering the right representations, semiotics and metaphors to sensory optimisation

within different types of creative practices.

3.1.6: Synaesthesia and Creativity

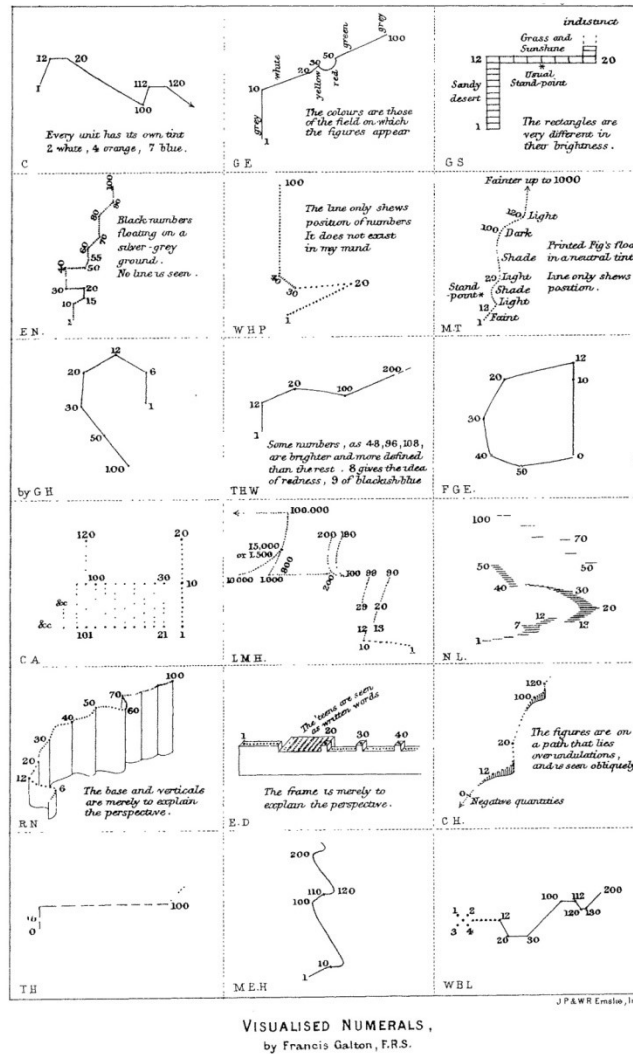


Figure.17 Galton's Study of Visualised Numerals in 1880 (Galton, 1880)

By looking into various synaesthesia experiences of different individuals, important questions have been raised. Why are synaesthetes seeing and experiencing such idiosyncratic elements in their reality? Are people who experience synaesthesia more creative than those who do not experience synaesthesia? Synaesthesia research was inspired by investigating the peculiar habits or language of an individual's mental state, such as externally projecting mental images or seeing numbers as patterns (fig.17)

(Galton, 1880, pp.85-91). The relationship between the two is probably one of the most controversial topics in synaesthesia research, according to many contemporary sources (Runco and Prtzker, 2011, pp. 597-604; Ward, Lake, Ely and Kaminski, 2008). Researchers, such as Lone and Tyler (2003, p.223), have analysed and found evidence of synaesthesia in a range of famous creative people, such as Wassily Kandinsky, David Hockney and Richard Feynman. However, some researchers (Ward, Lake and Ely and Kaminski 2008, p.128) are less than convinced about the validity of these claims. They state that the comparison between gifted individuals and the general population is misleading, on the grounds that it risks focusing on one spectrum, although there could be an even greater number of creative individuals who do not experience synaesthesia. Thus, research on this topic requires a considered approach.

The relationship between synaesthesia and creativity is a very complex topic. Although the speculative quality around the topic of synaesthesia has been embraced in art practices and other creative disciplines, the real associations between synaesthesia and creativity have not been sufficiently scrutinized (Mulvenna, 2012, p.10). Nonetheless, there are a few group of researchers, including Jamie Ward (2008) and Julia Simner (Hubbard, et al., 2013, pp.608-621), who have been discussing this relationship. However, particularly valuable insight on this topic can be found in Dr Catherine Mulvenna's research and her doctoral thesis *On Creativity in Synaesthetes*⁸. She states that creativity and synaesthesia were originally linked not because synaesthetic experience appeared to be creative or that creativity and synaesthesia seemed to be similar, but rather that synaesthetes appeared to be creative and exemplified creativeness (Mulvenna, 2012, pp.49-54). Perhaps Richard Cytowic's book, *The Man Who Tasted Shapes* (1993), could provide a meaningful example of this because, in the early days of modern synaesthesia research in the late twentieth century, this book increased interest and heightened synaesthesia research by describing the creative characteristics and intriguing behavior of those who experience synaesthesia.

⁸ Mulvenna studied her Doctorate in Psychology at University College of London (UCL). She worked closely with some of the leading synaesthesia researchers, such as like Larry Mark, Vilayanur Ramachandran and Edward Hubbard, while attending three different institutions (UCL, Yale University and Texas A&M)

Mulvenna's research, which elaborated the relationship between synaesthesia and creativity, concluded with important inferences as a result of her scientific research and analysis. Her research indicates that synaesthesia can be a positive predictor of high levels of creative cognition. This presence of synaesthesia, however, does not predict a specific ability for those individuals to transmit their creative, subjective ideas into a secondary medium. The reason for this is that although synaesthesia may offer supplementary inspiring materials for individuals, many other skills and capabilities are required to produce artworks or any other creative practices. Thus, creativity and producing artworks are associated with each other, but synaesthesia has a rather different relationship with each of them. Consequently, in other words, the existence of synaesthesia may heighten individuals' creative dimension or thinking, but not in communicating creativity via secondary media or in artistic aptitude (Mulvenna, 2012, pp.241-248).

The relationship between the two intangible subjects of synaesthesia and creativity motivated this research to consider whether there is a tangible way to use intangible synaesthesia to influence creativity in practical ways (see sections 4.7: Workshop & Toolkit & 6.2.5). My understanding of the literature related to creativity and synaesthesia fed the development of the various themes, participatory workshops and the synaesthetic-provocation toolkit (see sections 4.8: Participatory Design & 5.3: Workshop & Expert Feedback & 5.3.2: Themes / Tasks). The vital reason to discuss this area of literature in this thesis is not just to understand the relationship between synaesthesia and creativity, but also to envisage and speculate whether there is any practical opportunity in a design context within this relationship. Particularly, there is a lack of research regarding the benefit and usefulness of synaesthesia in present synaesthesia research, thus looking into this relationship from a designer's point of view may contribute to the discovery of unusual insights and perspectives within synaesthesia research (Charles, 2012; Beresford, 2014). This area of literature on synaesthesia in relation to creativity encouraged me to consider developing different tangible approaches to applying synaesthesia as an inspiration for generating creative ideas.

3.1.7: Redefining Synaesthesia?

Although various researchers seem to agree with defining synaesthesia as a neurological condition, in which stimulation of one sensory or cognitive pathway leads to automatic and involuntary experiences in a second sensory or cognitive pathway (National Health Service, 2014), there is ongoing disagreement regarding a more detailed definition of synaesthesia.

For example, in earlier studies by Vilayanur Ramachandran (Ramachandran and Hubbard, 2001a; *Neuroanthropology*, 2008), he pointed out several features that define synaesthesia.

- Firstly, synaesthetic associations are stable over time.
- Secondly, synaesthesia runs genetically in families through the X-chromosome.
- Thirdly, synaesthetic associations are involuntary.
- Fourthly, synaesthetic associations are unidirectional (however, this has since been questioned as Cohen Kadosh and his colleagues have proven the existence of a rare case of bi-directional synaesthesia (Gebuis, Nijboer and Smagt, 2009; Kadosh and Henik, 2006; Kadosh et al., 2007).
- Finally, he claimed that synaesthesia is a perception effect.

However, more recently, new research and perspectives have emerged and contributed to updating the definition of synaesthesia. For example, Cohen Kadosh and his colleagues research in 2007, which I have already mentioned in the list above, has challenged one of the most generally acknowledged definitions of synaesthesia: the directionality. Until recently, the majority of synaesthesia researchers considered synaesthesia to be unidirectional (Weiss, Andreas and Fink, 2009; Day, 2016). Unidirectional synaesthesia means that the synaesthete only experiences synaesthesia from one way, but not vice versa. For example, one may perceive the letter D as the colour purple, but they will not conceive of the letter D when seeing the colour purple. This potential of bi-directionality of synaesthesia brought a new possibility and spectrum regarding defining the subject synaesthesia. Moreover, most recently, one of the forefront synaesthesia researchers,

Julia Simner (2012), rejected the argument that synaesthesia is strictly a sensory perceptual phenomenon. Kadosh and Devin Terhune, in the department of experimental psychology at the University of Oxford, also completely advocated her perspective (Kadosh and Terhune, 2012). In relation to this point, it is worth mentioning that it was once widely accepted that the experience of synaesthesia is more common in female than male (Baron-Cohen et al., 1996), but later research by Simner and Carmichael (2015) has articulated that this is not the case. One reason for this difference is that males tend to volunteer less for research compared to females and are less likely to acknowledge having synaesthesia. Synaesthesia research also has not fully discovered the genetic aspects (such as debates on X and Y chromosomes running in families) of synaesthesia (Bosley and Eagleman, 2015). Currently, the progress of defining the topic of synaesthesia is ongoing, driven by scientific debates, in an attempt to provide a more precise definition of synaesthesia.

As a designer, I am intrigued to see how the scientific community has developed the definition of the subject of synaesthesia. This progress within the field of science has encouraged me to look further the current synaesthesia application research within the field of design (see section 3.2: Synaesthesia in Design). While the progress of defining the phenomenon of synaesthesia is ongoing within the field of science, along with its attempts to expand the scope of synaesthesia research to other subjects like creativity, metaphor and memory, this PhD research in design tries to explore practical applications of synaesthesia. It aims to do this by exploring different properties of synaesthesia, and valuing them as inspirational sources (see sections 5.1: Three Studies of Synaesthesia, 5.2: Synaesthetic-Provocation Toolkits then 5.3: Workshop & Expert Feedback).

3.1.8: Summary & What I learned

In section 3.1: Understanding Synaesthesia, I have explored the scientific foundation of synaesthesia that is relevant to my research topic from a large scope. This was to view the scientifically dominated landscape of synaesthesia research, and their perspectives in relation to my research concerns. Understanding this literature is important, as my research attempts to transfuse a creative interpretation within this paradigm are from a designer's perspective. The research on synaesthesia in relation to the design context in literature is relatively sparse, and a common thread within the scientific research of synaesthesia is to find a broader comprehension of how we may apply the idea of synaesthesia. Many researchers argue (Beresford, 2014) that the research focus on the topic of synaesthesia has been intensely focused on the synaesthetic experience alone; however, there is comprehensive interest and a significant number of inquiries emerging to seek beyond this scientific research setting. By understanding subjects that are relevant to synaesthesia from a more scientific perspective—such as the relationship with metaphor and creativity—this part of literature tacitly encouraged me to speculate on the tangible ways of using synaesthesia practically, and later influenced the exploration of different synaesthetic properties and development of the synaesthetic-provocation toolkit (see sections 5.1 & 5.2). By understanding and learning this research paradigm through literature, in the next section 3.2: Synaesthesia in Design, we will look outside the scientific analysis, with a particular focus on how the field of design has been adopting the phenomenon of synaesthesia.

3.2: Synaesthesia in Design

Although there have been many relevant and intriguing synaesthesia creative practices over the past three hundred years, which have covered a diverse range of subjects from music, metaphor, poetry and psychedelia (Brougher, et al., 2005), in-depth research and literature regarding applications of synaesthesia in design has been largely absent from theoretical analysis. From here, I will review how the idea of synaesthesia has been used and applied in various disciplines and will explore some of the relevant synaesthesia research in a design context that currently exists. I will then articulate and summarize what I have learned in order to elaborate how all the relevant literature in chapter 3 affected my thoughts and shaped my argument for this practice-based research.

3.2.1: Why Synaesthesia Studies in Design?

One of the exciting things about exploring the topic of synaesthesia in a design context is that it can introduce the idea and experience of a private world to the public domain. One's very private peculiar experience is a unique channel that could provide unusual opportunities for design. Particularly, believing and considering myself as a smell-to-colour and shape synaesthete, I believe investigating and researching potentials of this topic is a fundamentally delightful and encouraging journey of self-exploration and motivation.

The synaesthesia research that is available to us today is associated with various fields. These fields range from experimental psychology, neuroscience, visual arts, linguistic, and genetic, and are evident in emerging studies like neuro-aesthetics; synaesthesia has become attractive to various disciplines (Cordoba, 2013, p.178). Although the research on this topic is largely dominated by the field of science, the romantic components and poetic narratives of synaesthesia are frequently celebrated by the creative disciplines, and its broad expertise and sensory-based quality seem to provide holistic creative thinking and approaches within the contemporary design practice.

Research into synaesthesia has started to address a need to find its potential applications

beyond the scientific analysis of the phenomenon (Beresford, 2014). Although there is quite a lot of literature that covers various synaesthetic inputs in relation to different disciplines (e.g., poetry, music, fine art), there is very little so far from a design context (Haverkamp, 2013, p.9). This study tries to explore this boundary and attempts to contribute within this synaesthesia research paradigm. In the following chapters I will cover the boundary of this research and then share existing synaesthesia application research and observation within the context of design.

3.2.2: Synaesthesia Research and Boundaries



Figure.18 Richard Cytowic Criticizing and Discussing Some Synaesthesia Related Art Practices.

Before this research further explores synaesthesia implementations in a design context, I would like to clarify some synaesthesia research boundaries used for this study. This is because there is confusion about the term synaesthesia, as it has been used to cover a variety of issues ranging from metaphor, poetry and psychedelia over the past three hundred years. Pioneering synaesthesia experts Cytowic and Eagleman argue that these contrived applications should be carefully distinguished in order to resolve this confusion, as some people try to use it as an “intellectual idea of sensory fusion” (2009, p.13) (fig.18).

This artistic synaesthesia is problematic as it becomes an inversion of the definition of synaesthesia because the artistic expression of synaesthesia is not a diversity of perceptions from a single stimulus, but a collection of aesthetically driven harmonies elaborating one's artistic perception (Aldrich, 2005). Thus, it is important not to misguide the topic of synaesthesia with subjects like multisensory or linguistic aspects, while it is also important not to limit the discussion between synaesthesia and those interconnected subjects.

Although this writing has covered several sources and examples, such as multisensory, synaesthetic metaphors (see section 3.1.4) and ideasthesia (see section 6.2.1), this does not mean this research is considering them as synaesthesia but, rather, as complexly interrelated subjects in both the context of science and design. According to the author of *Synaesthetic Design*, Michael Haverkamp (2013, p.9), there is little in the way of literature that is generating debates regarding different approaches of synaesthesia application in design study; thus, referring these subjects into synaesthesia application research is a useful way to facilitate the discussion on concerns of synaesthesia application in a creative context. This will aid readers to foresee different insights, thereby allowing them to conceive a new way of observing and interpreting the subject of synaesthesia. Hence, while this research will have an awareness of considering those topics as synaesthesia, this research will include examples from various subjects such as affective connotation, music, fine art, performance and synaesthetic metaphor, in as much as they are appropriate to enhance the discussions of synaesthesia implementation in a design context. This doctoral research challenges to share a new interpretation and direction in synaesthesia application research and, in particular, investigating the usefulness of its provocative properties in a creative context. Thus, it is important to understand this viewpoint and recognize ambiguity to understand current synaesthesia research in design.

3.2.3: Synaesthetic Inputs In Different Contexts

The romantic components of synaesthesia have always been a fascination to the creative industries. Especially, the irresistible, sensitive quality has invited a variety of speculative thinking (Dann, 1998). From fine art practice to instrument design, they are broadly disseminated in many different forms. As I suggested earlier in this research, many scientists did not consider synaesthesia a topic worthy of further consideration. The lack of its objective proofs and incomprehensible properties were the biggest obstacles, at least until technological innovation re-opened research possibilities. Yet, its desirable assets have been often celebrated around other disciplines for a long time. From here, observations and some case studies ranging from linguistic approaches to spatial experiences will be examined. The point of this study is not to rigorously categorize different types of inputs or outputs. Rather, it is to view and speculate what and how various existing probable applications in different disciplines may motivate our understanding of potential synaesthetic inputs within the context of design.

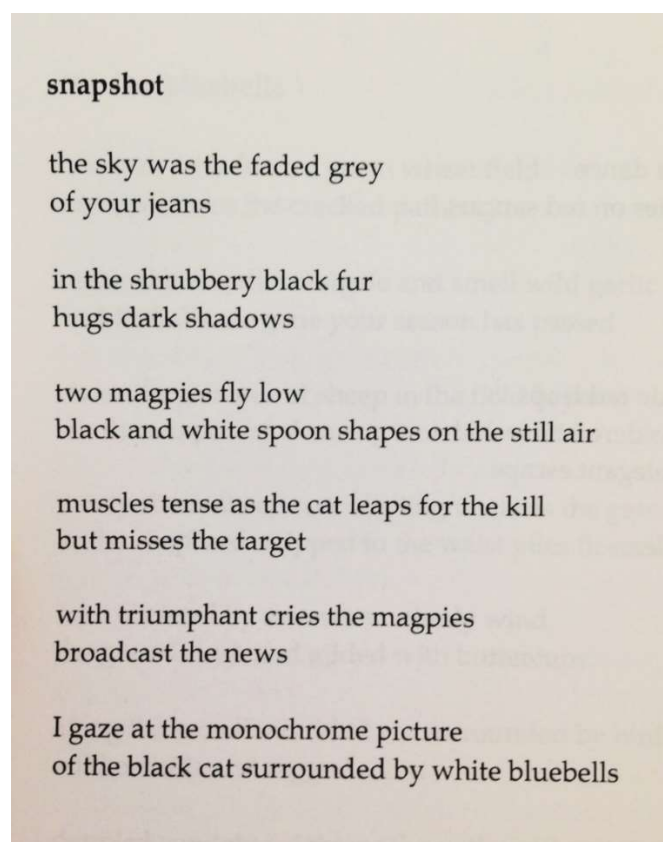


Figure.19 Poetry (Johnson, 2014, p.31)

The linguistic form of synaesthetic inputs is evident in literature, but it is especially easy to find them in poetry (fig.19). Poetry tends to combine different sublime sentences within a lyrical narrative, as it employs many synaesthetic phrases for communicative purposes (Ruddick, 1984). Even though it tends to exploit synaesthetic phrases, poetry is not a form of synaesthesia, because it fuses diverse senses and utilises all kinds of adjectives to induce a multiple aesthetic experience (Cytowic and Eagleman, 2009, p.14). Particularly, it shows how synaesthetic phrases or ones emphatic quality can communicate with the general public; it is a form of dialogue between the internal and external world.



Figure.20 Screen in Rimington's Studio (Brougher, et al., 2005)

There have been a variety of attempts to shape correlation using music for different purposes over the past three hundred years (Brougher, et al., 2005). As I suggested earlier in the example of Louis Bertrand Castel's attempt to design a colour-music organ in the eighteenth century (fig.9), the concept of music inevitably has a close relationship with instruments and performance. Relevant figures are pianist and inventor Mary Hallock-

Greenewalt, Russian composer Mikhail Matiushin, animator Oskar Fischinger and many more people besides, who have tried to build a correlation between music and other sources (Lucassen, n.d.). As an example, at the end of nineteenth century, the British painter Alexander Wallace Rimington tried to use his colour organ as an educational tool that could mix different colours. By projecting moving coloured light on a screen (fig.20), he then merged musical performance with a conventional two-dimensional painting to study hybrid kinetic art (Brougher, et al., 2005, p.71).



Figure.21 Composition VII, Wassily Kandinsky, 1913

As I mentioned in chapter 3.2.2, there is confusion about the term synaesthesia, as it has been used to illuminate a variety of issues ranging from metaphor, psychedelia and poetry over the past three hundred years. Although this may be true from a scientific point of view, because the science has to clarify its notion and principles, some fascinating artworks by famous synaesthetic artists still feed our interest in a creative context. Figure 21 is a famous painting by Wassily Kandinsky, who was highly fascinated by the

correspondence between colour and sound. Kandinsky had contact with many musicians (such as Arnold Schoenberg who opened the way for atonal music) and studied the cello for inspiration, as well as teaching painting at the Bauhaus in Weimar, where he offered opportunities to experiment on synaesthetic representation (Cordoba, Riccò and Day, 2014, pp.130-254; Wassily Kandinsky Net, n.d.). His experience regarding colours is impressive. "The deeper the blue becomes, the more strongly it calls man towards the infinite, awakening in him a desire for the pure and, finally, for the supernatural.. The brighter it becomes, the more it loses its sound, until it turns into silent stillness and becomes white." (Ward, 2006). How did he infuse or apply his experience of synaesthesia into painting? What can design learn from it?

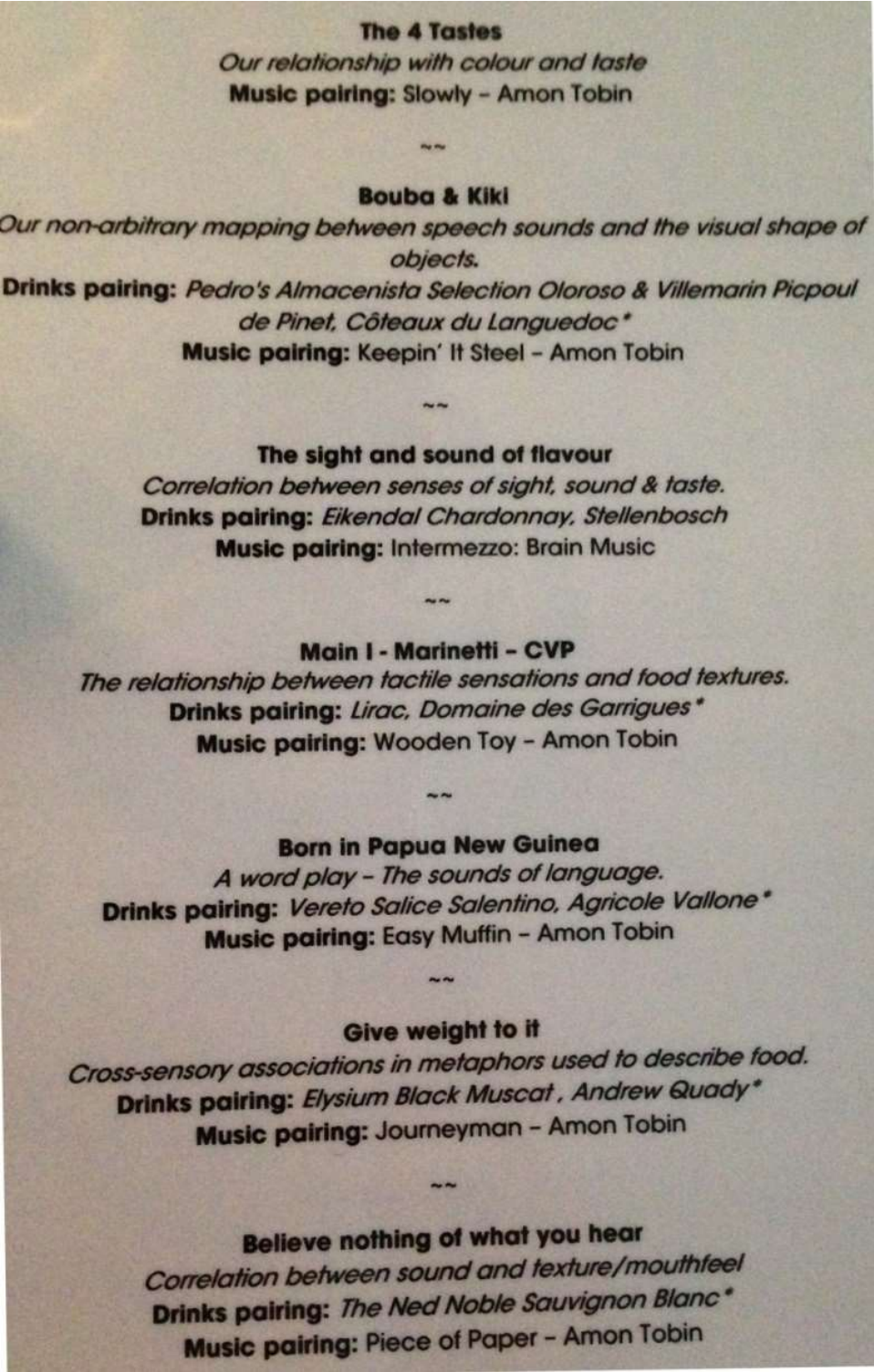


Figure.22 Kitchen Theory Menu



Figure.23 Bouba & KiKi (Left & Right) in Food Version: Kitchen Theory



Figure.24 Kitchen Theory Food

A carefully juxtaposed food on a warm plate is served at my table (fig.22 and 23). I started my dining and suddenly an odour of roasted pork was sprayed into the space. The taste of the food surprisingly changed significantly, as the smell stimulated my odour. They changed the smell every minute from roasted pork, mint, and strawberry. With each spray, the taste of the food followed accordingly.

This was my experience while participating in one of the latest synaesthesia related experiments, called Kitchen Theory. The event was organised by professional chef and author of *Molecular Gastronomy at Home* Jozef Youssef, and a leading crossmodal researcher, Professor Charles Spence, who is head of the Crossmodal Research Laboratory at the University of Oxford (Kitchen Theory, 2014). This participatory synaesthetic experiment provides the opportunity to think of the hidden properties that shape our mental images. Each menu (fig.22) is served and the participant has to finish their experimental food servings. The way the field of science tries to articulate and distribute the idea of synaesthesia in this creative manner is an inspiring thing to understand.



Figure.25 Punch Machine Game (Arcade Party Rental's image, n.d.)

The punch machine (fig.25) could be an interesting game as it exchanges the power of strength into a resulting number. The observation in this was that the concept of strength, determined by the punches thrown, could be translated into a concept of pain. Although there is no explicit correlation between pain and the resulting number, it still gives the idea of replicating synaesthetic properties or perhaps material transformation or information translation; it is a somewhat inspiring concept relevant to synaesthesia in a design context.



Figure.26 New Year Eve's Celebrations in London 2013 The World's First Multisensory Fireworks (Great London Authority, 2013)

In 2013, London displayed the world's first multisensory firework display for the end of year annual celebration (fig.26). The spectacular firework display was planned by the Mayor of London in collaboration with experimental flavour artists Bompas & Parr, and Vodafone (Greater London Authority, 2013). As the clock struck midnight, the skyline was covered by brilliant fireworks with an array of colours. They produced the tasty smells of strawberry, peach, and banana and were designed to be edible (Malm, 2013). The massive display took place along the banks of the River Thames, and it was perhaps one of the biggest multisensory experimentations to have ever taken place worldwide (Bompas & Parr, 2014). While multisensory is different from synaesthesia, this example suggests the possible scale of event possible within synaesthetic speculation.

3.2.4: Implicit Application of Synaesthesia

Throughout exploring the various applications of synaesthesia in a different context, there appears to have been two different types (implicit and explicit) of application, which apply or interpret synaesthesia in different ways⁹. The reason for categorizing this is that the inexplicable properties of synaesthesia have been covering and depicting a diverse range of issues (such as music, metaphor, poetry and psychedelia) over the past three hundred years (see section 3.2.2). Thus, uncovering and clarifying types of synaesthetic input into groups may aid readers to understand its diverse and complex implementation methods from different spectrums.

The main difference between implicit and explicit types of synaesthesia applications is that although both types of application are understandable within the context of synaesthesia, the implicit type does not deliberately refer to the idea of synaesthesia, but rather implies the properties of synaesthesia, while the explicit type clearly states the context of synaesthesia within its contents. Distinguishing these two may not seem very important, but a number of synaesthetic properties are hidden in the everyday “things” that surround us. Thus, viewing synaesthetic applications from a wider scope is necessary to both researchers and readers to view the extensive potential and features regarding synaesthesia applications. Particularly, currently there is little in the way of literature about the different typologies of synaesthesia application in design study. The PhD research focus was incubated and achieved throughout evaluating these various uncharted synaesthesia application methods and approaches. From here, I will focus the discussion on the implicit applications.

⁹ Synaesthetic application or synaesthetic imaginary within the context of design can be traced back to the middle of the eighteenth century. Mathematicians, such as Louis Bertrand Castel, tried to apply ideas from their observation of colours to pursue an intriguing experiment, which resulted in Castel designing an instrument that could produce coloured lights that harmonised with musical notes (fig.8) (Franssen, 1991, p.20).



Figure.27 "A Bigger Splash" by David Hockney, 1967

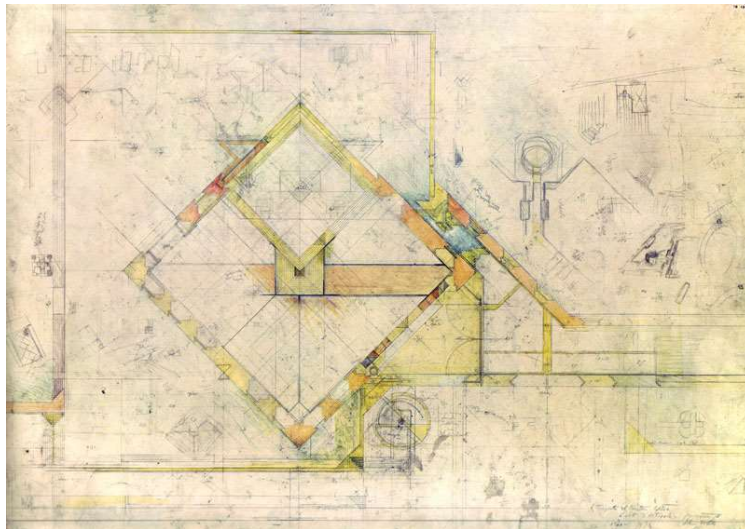


Figure.28 Architectural Drawing by Carlo Scarpa

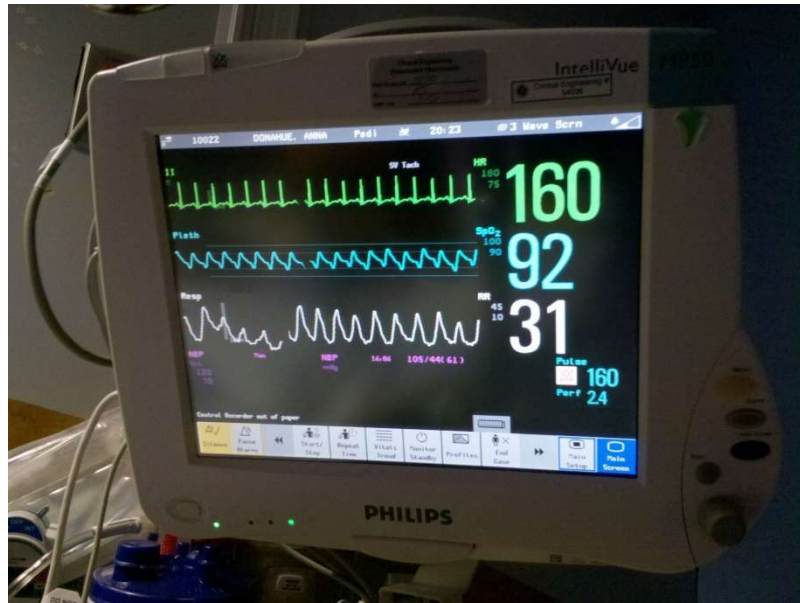


Figure.29 Medical Grade Heart Rate Monitor

There are projects or things that cover synaesthetic features or embrace relevant characteristics that are discussable within a synaesthetic context, which, however, are not designed or intended to deliver any idea related to synaesthesia. These types of projects, or 'things', can be seen in the field of design as well as in many different disciplines, ranging from fine art practice (such as artwork by David Hockney (fig.27) to architectural illustration, like the one by Carlo Scarpa (fig.28) (Moeller, 2007). An artifact such as a heart rate monitor (fig.29), which allows one to measure heart rates in real time using graphs (visual) and sound (auditory), may also encompass synaesthetic elements as it transfers a type of information or experience into another type of information or experience. It replicates the experience of synaesthesia, where a sensation in one of our senses, such as smell, triggers a sensation in another, such as taste. These types of projects or things do not refer directly to synaesthesia within their contents but are explicable in a synaesthetic context. They provide opportunities to speculate about synaesthetic associations. They usually cover the topic of multisensory, metaphor and arbitrary mapping between different sensory associations, information and experience.

Below are a few more examples of implicit applications that may be relevant to synaesthesia within the context of design:

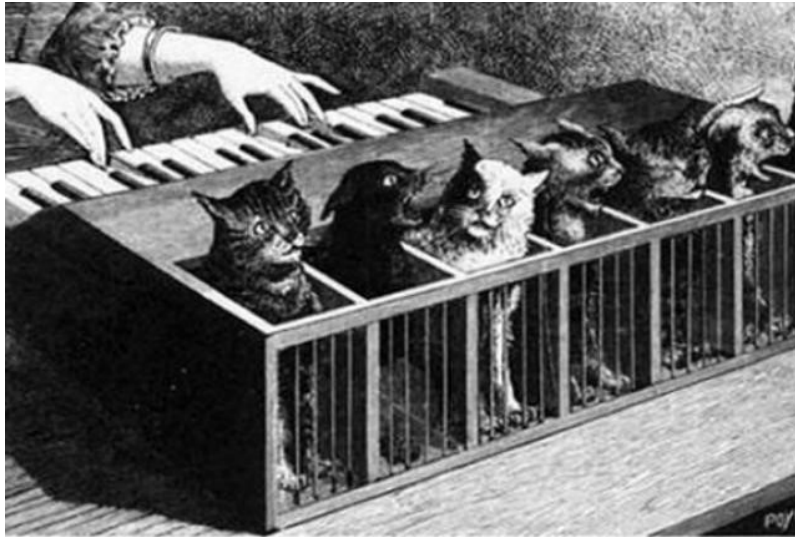


Figure.30 Cat Organ (Wallop, 2010)

- **Whistling kettle:** A whistling kettle starts to whistle once the water inside heats up and creates steam. It creates an intense and high pitch sound as it heats up accordingly. The association or correlation between the different temperatures, the amount of steam, the noise created by them and even the intense atmosphere the noisy kettle creates can be discussable in a synaesthetic context.
- **Cat organ:** The cat organ (fig.30) is a musical instrument that pulls the tails of a line of cats underneath a keyboard to make them cry in pain when keys are struck. The cats are lined according to the tone of their voices. No one knows whether it has really been built (Wallop, 2010).
- **Smell of interior and sound of a slamming car door:** Many automobile companies (such as Volkswagen, BMW and Bentley) design user experiences for the sound of a closing door, the smell of the interior and even the detail sounds of the engine (Baker, 2013; Kay, 2015). Although these experiences may associate more closely with multi-sensory experience or discovering the right representation or metaphor for specific functions, they are fairly good examples of synaesthetic connection between reality and our mental imageries.

3.2.5: Explicit Application of Synaesthesia

Unlike the implicit type, the explicit type tries to embrace and refer to the topic of synaesthesia in the project context. People working within this field usually directly cover and refer to the topic of synaesthesia within their creative practices. I will examine two synaesthesia-aimed projects done by different types of creative experts to examine how the idea has been used by them.



Figure.31 Neil Harbisson: The World's First Cyborg Artist

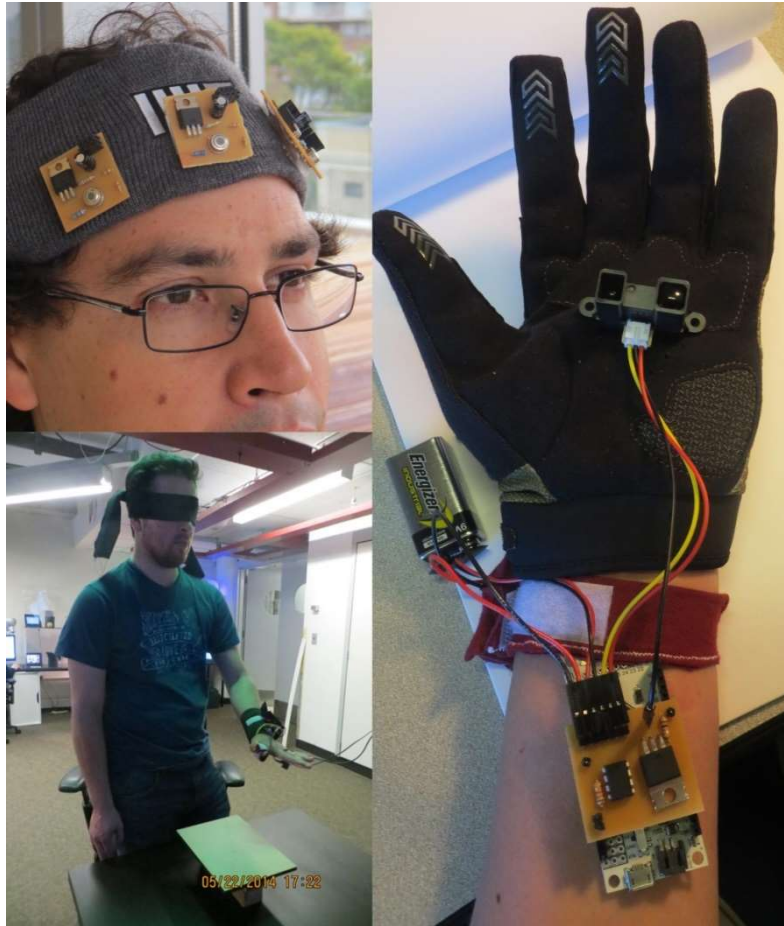


Figure.32 “Digital Synaesthesia” by Santiago Eloy Alfaro Bernate

Digital Synaesthesia is a project by a recent (2014) PhD graduate from the Massachusetts Institute of Technology (MIT) Media Lab, Santiago Eloy Alfaro Bernate, who has a substantial interest in user experience and wearable technology (Bernate, 2015). One of his projects is a headband design (fig.32, left above), which uses infrared (IR) sensors that allow users to perceive micro temperature changes by creating vibrations on the forehead that we are unable to feel on our skin. Another project (fig.32, left below and right) uses a similar method but combines a vibrator with a proximity sensor that can discern basic shapes by vibrating the tester’s wrist without any visual clues (Ibid.). One of the interesting things to note about these *Digital Synaesthesia* projects is that they try to use mobile technology to create a user experience of perception that is outside of the normal human sensory spectrum. In the future, this could mean that if microscale sensors allow people to perceive everything beyond their bio-sensory capabilities and physical dimensions (e.g. detecting intangible elements to a swift information exchange between the senses),

human beings may become almost transcendental. Although there are still many other critical obstacles researchers have to contend with, it is still a conceivable hypothesis that could feed our speculations¹⁰. The focus of project *Digital Synaesthesia* reflects well the potential of integrated artificial perceptions; it illustrates how the idea of synaesthesia could be developed together with the concept of mobile technology¹¹.



Figure.33 “An Eyeful of Sound”, by Samantha Moore, 2010

Dr Samantha Moore is an animator who works mainly with animated documentary. During her PhD, she explored prosopagnosia (face blindness) and phantom-limb syndrome in relation to animation (University of Wolverhampton, n.d.). She was commissioned to make a film for the Wellcome Trust about synaesthesia together with one of the leading synaesthesia experts and neurologist Dr Jamie Ward (Ibid.). Although two people from different disciplines, they collaborated and created a ten-minute animation called *An Eyeful of Sound* (fig.33). The animation illustrates different types of synaesthetic experiences with background narrations explaining basic information on synaesthesia. The animation consists of rich graphics and has been carefully planned to depict the individual’s experience of synaesthesia. One noticeable thing is that the animation was highly illustrative and romanticized; it subsequently provided an opportunity to consider why the realm of synaesthesia should always be so poetically described. Perhaps the synaesthesia experience itself is truly poetic, but it could be asked whether exploration of

¹⁰ Artist Neil Harbisson (fig.31) (Jeffries, 2014) is a good example within the context of Digital Synaesthesia. Harbisson, who was born completely colour-blind, implanted an antenna to his brain in order to convert colour frequencies into sound vibrations.

¹¹ The topic of synaesthesia and mobile technology may also associate to the concept of bio-hacking and cyborg, especially regarding sensory extension.

the negative aspects (such as discomfort and painful components) of synaesthesia may open unusual probabilities and inspiration within synaesthesia research.

3.2.6: Synaesthetic Design



Figure.34 Vacuum Cleaner

Although various disciplines are intrigued by the romantic, imaginative and extraordinary quality of synaesthesia and its application in creative practices, there is little in the way of literature that generates debates in relation to synaesthesia application within the context of design (Haverkamp, 2013; Dann, 1998). That said, one of the notable pieces of literature existing in this domain is Michael Haverkamp's idea of synaesthetic design.

Haverkamp's approach to and focus on synaesthetic design is an attempt to optimise the experience between the user and products. This attempt entails a comprehensive consideration of the various sensory channels in product design and styling. The major concern of synaesthetic design by Haverkamp is to explore and study beyond the visual form that has been the focus of industrial product design during the last few decades. He was initially inspired by the experiments carried out at Bauhaus that considered the connection between visual and auditory features, in which Wassily Kandinsky and Paul Klee contended with the correlations between music and painting. Haverkamp endeavored to extend this idea of sensory connectivity to further senses for cross-sensory interplay and experience in everyday life in relation to Gestalt principles¹² (Haverkamp, 2010; Haverkamp, 2013, p.126).

A vacuum cleaner (fig.34) may be one tangible example that best depicts the idea of Haverkamp's synaesthetic design. Vacuum cleaner has a number of different features that interact with users' experiences. The visual appearance of its body may indicate its possible capacity, sufficient or insufficient hose flexibility, high or low mobility, accessibility of switches and other elements. The sound produced when the vacuum cleaner is operating may allow users to interpret the suction power and cleaning efficiency. The suction sound may also reflect a leaky hose. During its operation, the vacuum cleaner may dispense an unexpected smell, which may indicate overheating, a potential safety hazard (Haverkamp, 2013). The idea of synaesthetic design is about effective communication design for users. Haverkamp argues that the design of a product

¹² Gestalt is a term used in psychology that means "unified whole". It attempts to describe how people tend to establish visual elements into groups or unified wholes when certain principles are applied. Example principles or laws are proximity law, common fate principle, similarity principle, continuity principle etc. Gestalt principles or laws: see Wolfgang Metzger's *Laws of Seeing* (1936/2006).

should deliver the right representations of its expected functions through coordinating all the participating sensory channels to maximise users experience and recognition. A product should convey messages that motivate customers to think: “That’s exactly the product I need – it’s easy to handle, it looks and feels good, it sounds nice, and I feel good about it.” (Haverkamp, 2013, p.14).

Although a number of research projects discuss the idea of sensory maximization, ergonomic and sensory orchestration for user experience, these are mainly found within the field of vehicle design, and they do not normally associate the context in relation to the subject of synaesthesia but tend to refer to ideas about sensory marketing, branding or multisensory perception (Ho and Spence, 2008; Laack 2014; Baker, 2013; Kay, 2015). Therefore, the previous paragraph has focused more on Haverkamp’s view on synaesthetic design as the context clearly states and associates with the subject of synaesthesia.

Michael Haverkamp is not the only person to have used the term synaesthetic design: Giovanni Anceschi and Dina Ricco have also used it, but they have focused their studies on cross-sensory correlations and experience. As such, their objectives when considering the idea of synaesthetic design differed from Haverkamp’s. The main ideas or motives they roughly synthesised regarding synaesthetic design in their early research in 2000 are as follows (Ricco and Anceschi, 2000, p.5):

1. Incoherent sensorial data slows down the processes of working out information.

Every time we need to deal with sensorial data that contains complicated information, the data analysis becomes delayed due to sensorial conflict. It slows down the process of communication. For example, the word “red” written in green will slow down the reading process as the sensation related to the colour negatively affects or interferes with the meaning of the word itself (Stroop, 1935).

2. In the case of contrasting sensorial data, the correct data are not always the most credible ones.

“The data pertaining to some registers, such as the visual one, are endowed with an index of credibility, and therefore with a communicative potential, which is superior to others. This happens apart from the exactness of the information conveyed. It may therefore happen that in

the presence of, let us say, tactile and visual information in contrast with the quality of some object – for instance the size – we are disposed to believe in the visual information, though it does not correspond to reality. There are indeed some hierarchies among the several sensorial registers according to which one may prevail over the other only with reference to the choice of the channel and not of the content conveyed.” (Ricco and Anceschi, 2000, p.5; Rock and Victor, 1964).

3. The concentration of information on just one sensorial medium easily provokes mistakes.

If there is a high number of data to be delivered (for example, a pilot’s console), the information delivery needs to have a balanced distribution through various registers. The over-articulated information on just one sensory channel may create mistakes in receiving valuable information or experience.

4. Coherent sensorial data of different registers produce more communicative effectiveness than the same data taken one by one.

The mixture of coherent sensorial information may encourage the communication process. Precisely, the availability of additional sensorial registers allows the message to acquire a dual potentiality:

- It simplifies the process of understanding information and receiving feedback, as there is a certain advantage of communicating via secondary channels.

- It reinforces the processes of memorisation and remedying to forgetfulness, since possible “gaps” of memory in one register are counterbalanced by remembering in another way. Thus, the main aims of a design of synaesthetic communication are as follows:

1. the search for coherent sensorial information.
2. the reduction of the sensorial overload to only one modality.
3. the careful choice of the sensorial registers according to the communicative aims.
4. the balance of the informative “loads”.

As such, while Haverkamp’s perspective on his synaesthetic design is to view all possible forms of cross-sensory connections for maximised user experience towards a designed product, Ricco and Anceschi’s (2000) idea of synaesthetic design is more concerned with the idea of cross-sensory substitution or translation. Their research (Ricco and Guerini

2002; Ricco, Belluscio and Guerini, 2003) studies the mutual correlation and congruence between two different sensory stimuli. For example, they studied the relationship between visual and auditory features to analyse the interferences generated by the combination of specific elements (such as depth, colour background, shape and texture) of two different senses (Ricco and Guerini 2002).

Ricco's more recent paper (Ricco, 2016) for the Design Research Society shares further ideas of synaesthetic design. She attempted to associate the idea of synaesthetic translation in relation to sensory disability and accessibility. While describing the idea of synaesthetic translation and its historical timeline by mentioning objects such as Louis-Bertrand Castel's harpsichord (fig.9, Section 3.1), she has suggested three methods (verbal to oral & verbal to tactile & music to visual) of overcoming sensory barriers by articulating a few case studies for a visually impaired audience (Ricco, 2016, pp.5-9), and audiences with other disabilities (Cordoba, Ricco and Day, 2014).

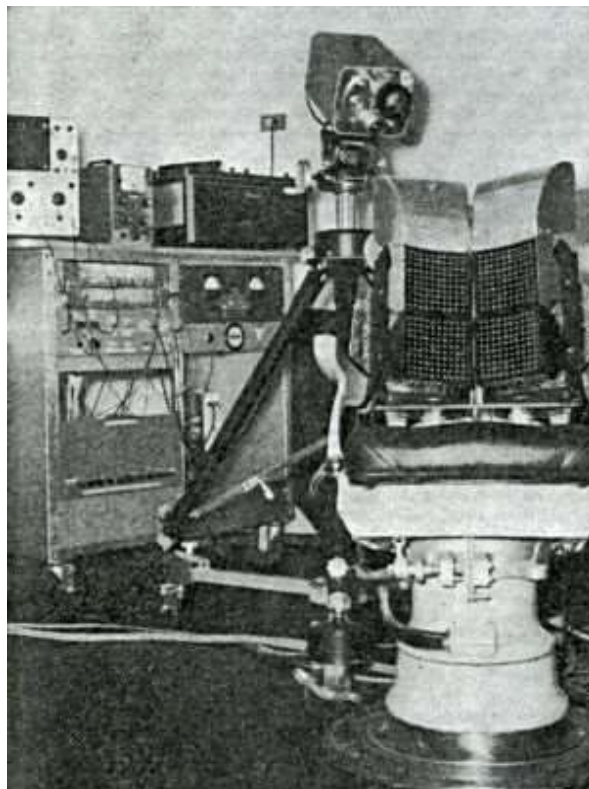


Figure.35 Bach-y-Rita, 1969

A notable omission from Ricco's publications is the work of Paul Bach-Y-Rita (1934-2006), who is widely seen as the first figure to propose the idea of sensory substitution or translation in relation to disability and neurological disorder (Doidge, 2008). Although Paul Bach-Y-Rita was a neuroscientist who pioneered neuroplasticity, his idea of sensory substitution has been also referred to as "controlled synaesthesia" (Hurley and Noe, 2003). Figure 35 is one of the relevant works by Paul Bach-Y-Rita and his colleagues. The dental chair, designed for blind people, has four hundred solenoid stimulators arranged in a twenty-by-twenty array. The solenoid stimulators vibrate against the skin of the back of a blind person. These vibrations were created by electric signals that corresponded to an image transmitted from a computer. The stimulators function like pixels, vibrating the dark scene and holding still the brighter shades (Rita, Collins, Saunders, White and Scadden, 1969, p.963).

As mentioned in section 3.2.2: Synaesthesia Research and Boundary, there has been a lack of articulation about the wider debates of the subject synaesthesia in design literature and research. Thus, this section has covered the existing term "synaesthetic design" to clarify how the subject synaesthesia has been implemented in the landscape of design research.

3.2.7: Digital Synaesthesia

Digital synaesthesia is a relatively new term or theme that began to show up in synaesthesia research literature in 2005. Especially, it began to appear more often in the field of art research after the University of Applied Arts Vienna conducted a research project between 2013 and 2016 called Digital Synaesthesia. This research project was a transdisciplinary collaborative project between media artists, scholars and cognitive neuroscientists. It aimed to find a way for people to experience synaesthesia through digital technology by exploring how the multimedia aesthetics of digital technologies is changing human perception and how digital art can explore, represent and reflect on these changes. Seventeen international media artists were involved in this research project and created fifteen artworks under the theme of digital synaesthesia to create

translational and cross-modal sensory experience for non-synaesthetes (Gsöllpointner, Schnell and Schuler, 2016). This term was also used by a PhD student in the MIT Media Lab, where his focus was more on the potential of integrated artificial perceptions in relation to the concept of mobile technology. His idea of digital synaesthesia was to help us become closer to our physical world in this modern era instead of existing in a virtual social bubble in which we are completely absorbed in our device screens (Bernate, 2015, p.19). He used the idea of synaesthesia with his three design approaches (sensing, translation and feedback) with the focus on mobile technology (see also chapter 3.2.5: Explicit Application of Synaesthesia). This term was also used under the keywords music, art, visualization, sonification and digital media by a professor in the department of Art and Art History at University of Alabama who associated digital synaesthesia with the idea of data mapping and information design within digital technology (Evans, 2005, p.5).

By viewing the overall themes of two different studies, we may know the term digital synaesthesia is frequently used as the idea of sensory experience translation or substitution in relation to digital platform. The term has emerged very recently, but the debate is not widely covered within the synaesthesia research and community. The idea may also be connected to Dina Ricco's synaesthetic design (see chapter 3.2.6: Synaesthetic Design) as they all embrace the concept of translation in relation to digital synaesthesia (although she did not mention the term digital synaesthesia directly).

The evolution of our modern technologies has gradually made people feel more isolated from the physical world and, perhaps somewhat ironically, led us increasingly to interact with our device screen in our everyday living (Bernate, 2015). Many thoughts regarding this issue have been pointed out by different thinkers, and most have arrived at the conclusion that we are surrendering or compromising our social customs in favour of virtual ways of connecting to one another and to the world (Turkle 2011; Thompson 2013). In this context, considering the relationship between digital technologies and synaesthesia can be meaningful in learning about human experience and interaction within the current digital era. The idea of digital synaesthesia will be an intriguing avenue to explore for future studies.

3.2.8: Summary & What I learned

In chapter 3.2: Synaesthesia in Design, I reviewed how the idea of synaesthesia has been used and applied in various disciplines. By exploring its application within the field of poetry, music, fine arts, science, public engagement, daily artefacts and, then, studying the existing synaesthesia application research in design, we can learn how broadly synaesthesia has been interpreted in diverse contexts with different concerns. However, relatively speaking, there is a lack of research on the topic of synaesthesia within the field of design. Particularly, the majority of the research and interpretation on synaesthesia application in design research has not investigated beyond the idea of cross-sensory substitution or sensory optimization regarding mass products in design. Thus, seeking its further implementation, especially in relation to its extensive provocative quality, seems a valuable investigation in future synaesthesia research in design. Although the provocative and imaginative characteristics of synaesthesia have inspired various creative practices in different disciplines, current design literature has not fully articulated its further potential. As such, we may discover and suggest some of the approaches and insights of applying the idea of synaesthesia as a provocation in design study. What are the methods of applying synaesthesia as a provocation within the context of design, and what insights can the field of design learn from it? In chapter 5: Design Studies (after the next chapter 4: Design Approaches), we will discover different provocative qualities and characteristics of synaesthesia through examining various design practices that have been conducted throughout this practice-based PhD. Following this, we will then move on to articulate how the discoveries of the inspirational properties of synaesthesia have affected the creation of the synaesthetic-provocation toolkit that are designed to encourage the idea generation process.

4. DESIGN APPROACHES

This chapter will outline the methodology of this research, which assisted in shaping the mindset and perspective for this practice-based PhD.

4.1: Radical Constructivist Epistemology

4.2: Phenomenology

4.3: Anxiety

4.4: Antidisciplinary Mindset within Interdisciplinary Subject

4.5: Practice-Based Research

4.6: Boundary Objects

4.7: Workshop & Toolkit

4.8: Participatory Design

4.1: Radical Constructivist Epistemology

I consider a radical constructivist epistemology as my base for this research. I value all the individuals' thoughts, experiences and learning. By reflecting on our experiences, we establish our understanding of the world we live in. Each of us generates our own rules and mental models, which we use to make sense of our experiences. Therefore, there is no "absolute" reality that is to be found independent of all experience. Within this frame, radical constructivism maintains that individuals' experiential world or value can be explored, discovered, and this exploration can encourage us to act, think and approach situations differently and, perhaps, better. (Glaserfeld, 1981; Watzlawick, 1984; Larochelle, Bednarz and Garrison, 1998, pp. 23-28).

It may not be the best idea to oversimplify the context of radical constructivism, but I think Glaserfeld's (Watzlawick, 1984) metaphor of burglars, key and lock describes well how one may create their path to achieve their goal. In his article Introduction to Radical

Constructivism (1984, p.3), he uses metaphors to explain his view on radical constructivism; “A key fits if it opens the lock. The fit describes a capacity of the key, not of the lock. Thanks to professional burglars, we know only too well that there are many keys shaped quite differently from ours but nevertheless unlock our doors. From the radical constructivist point of view, all of us – scientists, philosophers, laymen, school children, animals, indeed any living organism – face our environment as the burglar faces a lock that he has to unlock in order to get at the loot.”

Each experience of synaesthesia differs from one person to another, even when they experience the same type. This PhD research began by trying to understand the peculiar private world of individuals’ synaesthetic experiences from a designer’s perspective. Throughout this exploration, I have developed the synaesthetic-provocation toolkit, which potentially facilitates people’s ideation process, and was developed based on discovered properties of synaesthesia (see sections 5.1: Three Studies of Synaesthesia & chapter 5.2: Synaesthetic-Provocation Toolkits). These synaesthetic properties were valued and used to establish different approaches of synaesthesia application within the field of design. This developed value later influenced other researchers’ perspectives through different external research activities and workshops (see appendix A - K). This qualitative research development and process show the way that collected individual’s private experiences of synaesthesia could influence the world. This way of research, therefore, adopts a strong constructivist (radical constructivist) stance as a worldview or mindset for generating new knowledge throughout this PhD research. This view also links to phenomenology, as the source of interpretation was largely inspired by synaesthetes and their experiences of synaesthesia.

After I adopted a radical constructivist epistemology in this PhD research, I realised the need to use qualitative research as one of the exploratory approaches. Qualitative research attempts to gain an understanding of the underlying reasons, perspectives and motivations; it provides insights into different problems or encourages one to develop ideas and thoughts (Creswell, 2013). This research explores synaesthetes’ experience, perception and meanings from within their complex worlds. Thus, qualitative insights are crucial in this PhD research development in relation to discovering values and meanings.

4.2: Phenomenology

The domain of phenomenology is all about human experiences. It studies structures of conscious experience. Phenomenology is the study of appearances; of how phenomena and things (e.g. people, objects and events around us) appear in our experience from the first-person point of view. It also includes the reflection and dialogues of our own conscious experience as we experience them. Experience embraces not just passive experiences, such as smelling or hearing, but also active experiences, as in walking, bleeding or staring. Phenomenology counts as one of the leading traditions in twentieth-century philosophy (Russell, 2004; Zahavi, 2008; Smith, 2013).

Edmund Husserl (1859–1938) established phenomenology, but it was not exclusively his invention, though he developed it into a systematic philosophical approach and method with certain definite goals. However, it has often been mentioned that all post-Husserlian phenomenologists distanced themselves from its original approaches (Smith, 2013; Zahavi, 2008). Other prominent exponents include “Adolf Reinach (1883–1917), Max Scheler (1874–1928), Edith Stein (1891–1942), Martin Heidegger (1889–1976), Aaron Gurwitsch (1901–1973), Roman Ingarden (1893–1970), Alfred Schütz (1899–1959), Eugen Fink (1905–1975), Jean-Paul Sartre (1905–1980), Maurice Merleau-Ponty (1908–1961), Simone de Beauvoir (1908–86), Emmanuel Lévinas (1906–1995), Hans-Georg Gadamer (1900–2002), Paul Ricoeur (1913–2005), Jacques Derrida (1930–2004), Michel Henry (1922–2002), and Jean-Luc Marion (1946–)” (Zahavi, 2008, p.661).

Phenomenology has almost direct relevance to the field of design as design challenges to explore and innovate human experience, interaction and the technological applications that shape our physical, social and cognitive environment (Gallagher, 2013). This study explores human experience (synaesthesia) and the way humans express their perception in order to interpret the phenomenon of synaesthesia. By examining people’s (e.g., synaesthetes, workshop participants and interviewees) experience and perceptions through projects, a toolkit, workshops and interviews, this PhD research was able to validate or recognize the potential usefulness of the provocative properties of

synaesthesia in generating creative ideas. This means that without my subjective, intuitive insights and understanding into the phenomenon of synaesthesia and people's experience, this research may not have led to these outcomes. From my perspective, these are some of the elements:

- The way I adapted workshop-participants feedback was highly influenced by my understanding of phenomenology, particularly in terms of evaluating the feedback after having spoken to the participants (see section 5.3: Workshop & Expert Feedback). For example, some participants found card-A's fixed translation approach inspirational, but I decided to replace card-A with a new card, card-B, as I believed it would provide better accessibility, combinations and interactivity.
- In section 4.3: Anxiety (the next section), I list the ways in which anxiety has influenced my research direction. I am separating anxiety from phenomenology to emphasize more about its effects in relation to my research development.

This research, therefore, adopts phenomenology as one of its key approaches, allowing me to collect people's qualitative data and to construct my interpretation and research landscape. In addition, as I was initially trained as an industrial designer, the phenomenological approach acknowledges how this training informs my logic and research direction (also see the next section).

4.3: Anxiety

This entire PhD research direction, design practice and thought was affected by both my conscious and unconscious anxiety, and this may be an unusual approach in design research. However, I firmly believe this anxiety shaped the atmosphere or aura of my mindset and played a vital role within my thought development. I would like to separate this from phenomenology (see section 4.2) or constructivist epistemology (see section 4.1). Although this experience of anxiety could have been included in the above two sections (4.1 & 4.2), I wanted to specifically articulate this experience separately in this thesis, to

emphasize its importance and effects. The anxiety radiated and influenced my creative interpretation and approach from the beginning to the culmination of this PhD journey.

The nature of PhD research requires one to focus on and be concerned about a single topic for several years. This has placed a limit, although reasonable, on the degree in which I have been able to view or tacitly explore other creative themes, subjects and logics, and it exerted an extensive pressure that slowly dried up and partly fractured my flexible creative environment. Although this undesirable experience later inspired me to establish the idea of synaesthetic-provocation, an idea that offered much flexible compatibility in relation to various creative themes and tasks, the single-focus nature of PhD research in relation to a design discipline did not initially offer me a wholly encouraging environment. I indeed do understand the nature of doctoral research, but combining the nature of PhD research together with the design discipline, where elastic creativity flows, I had to compromise and negotiate between lateral thinking and logical articulation. This subtle, constant discomfort (or, I would say, the “mental war”) throughout this research influenced my overall research mindset and practices. This phenomenon influenced the design practices, research direction and the interview contents within this PhD research to a certain degree.

Below are some examples as to where and how these anxieties influenced this PhD research.

1. Compromising creative ideals—focusing on one specific interest—was a great pain throughout this PhD research. This anxiety, or what I would call ‘over-accumulated anxiety’, directed or forced me to think of how best to avoid this undesirable cognitive environment. Nonetheless, this negative atmosphere motivated me to create different creative channels for the workshops (see section 5.3.2: Themes / Tasks), and this accessibility and openness helped me to neutralize my worry and anxiety by introducing me to different creative spheres. For example, different workshop themes, such as creating toys, robotics and HCI, were developed to open up the restricted atmosphere of the PhD. Therefore, my accumulated anxiety became an empowerment for diversifying

the research interest, which assisted me to conceive the idea of synaesthetic-provocation (see section 5.2: Synaesthetic-Provocation Toolkits).

2. Both the project name and context of Angry Red (see section 5.1.2.2: Prop 2 – Project: Angry Red) were directly influenced by the anxiety. Compromising creative ideals was one of the anxieties that partly influenced this project in terms of the naming and the destructive aspect of the project.

3. I purposely interviewed some anger-related synaesthetes as I was experiencing a type of anger or uncomfortableness while conducting certain parts of this research. These interviews later shaped an opportunity to conduct a project (Angry Red) through a story or narrative of synaesthesia. This design allowed me to consider the property of narrative as one means to apply synaesthesia as provocation.

4. Three different cards were similar to the first version of the translation card (see section: 5.2.1: Synaesthetic Translation Tool). They are the anger, the pain and the stress cards. This similarity was not a mistake; the cards reflected my broad interest in those pain-related subjects that I experienced while interviewing synaesthetes.

4.4: Antidisciplinary Mindset within Interdisciplinary Subject

The dynamic knowledge exchanges between design as a discipline and various other fields have helped design to continue to expand its boundaries of knowledge, even though design as a discipline is in the midst of a crisis from a variety of different perspectives (Cross, 2001; Bremner and Rodgers, 2013). This enlarging scope and a number of territorial engagements within multi-faceted design environment also induced me to experience an identity crisis in a way.

Throughout the past several years, I was always confused whether I should introduce myself as a designer, industrial designer, design researcher, synaesthesia researcher, technologist, design engineer, maker, installation artist and so on. While the current fast-moving environment in design indeed gave me a little trouble in establishing my identity, it also led, eventually, to a situation in which I was freed from the need to contemplate how other people consider my identity. This experience motivated me to move from interdisciplinary thinking to an antidisciplinary mindset as I was not able to categorise myself into a particular discipline.

Joi Ito (Stinson, 2016), director of the MIT Media Lab, pictures antidisciplinary as a massive amount of white space between the little black dots on a huge piece of paper, where the black dots represent disciplines and the paper represents “all sciences”. Although he acknowledged the importance of disciplines, he suggested focusing on a higher mission to change in academia and research to allow people to view the wide spaces between disciplines – white spaces, the antidisciplinary space (Ito, 2014). From this perspective, I have adopted an antidisciplinary mindset to conduct this PhD research as I have absorbed countless different insights, qualitative information and experience from innumerable different domains, which makes it difficult to fit this research within an interdisciplinary framework. As such, the outlook of the research has shifted; it is no longer about people from different disciplines working and sharing perspectives together, but an attempt to study and discover the white spaces of study that have their own meanings – my own constellation. Having this mindset has allowed this design practice-based research to deal with an interdisciplinary subject, synaesthesia, and associate with two key disciplines: cognitive neuroscience and design.

Although the modern day field of synaesthesia research is largely dominated by modern neuroscience (see section 3.1: Understanding Synaesthesia), the interdisciplinary nature of synaesthesia research inevitably requires that it be explored and discussed from different perspectives, including human experience, perception, memory and language, and it must deal with a variety of qualitative data from different people in order to process scientific analysis. The beginning history of synaesthesia research itself was interdisciplinary, and there are only a few subjects in science that can embrace such a

variety of sub-disciplines (Jewanski, et al., 2013). Going back to 1873 (before Galton's research in Nature journal in 1880), when one of the Nussbaumer brothers wrote an article regarding their self-observation of synaesthetic experience, reviewers of Nussbaumer's article did not initially know where to place this observation; they finally published it between articles about cholera and ovariectomy. Later reviews for this article were found in a journal for medical sciences and in a journal for physicians in practice (Jewanski, et al., 2013, p.150). Today, since its interdisciplinary beginning, synaesthesia research is receiving attention from multiple disciplines, from the field of science to fine art (Brougher, et al., 2005; Dann, 1998, p.x). In this context, this PhD research tries to situate itself within an antidisciplinary space and mindset while exploring a highly interdisciplinary subject to discover its own meanings and values.

4.5: Practice-Based Research

The greatest thing about practice-based research to a design practitioner is that it enables the practitioner to achieve both academic merits and professional skills as a designer (Nimkulrat, 2011, p.58; Biggs and Karlsson, 2010; Fletcher and Mann 2004; Smith and Dean, 2009). As I am a design practitioner and researcher, this was one of the reasons that I am adopting practice-based research as one of the methods or approaches for this PhD study. However, although the practice-based form of research is widely adopted in humanities-based research culture, one of the current ongoing debates in design discourse concerns how best to document and articulate realities of research through design practices (Wallace, Yee and Durrant, 2015). These debates to explore and invite further experimental perspectives and understanding regarding research and practice are still ongoing through different conferences and seminars.

In this PhD research, the aim of the design practices is to gain new insights for research by debating through the artefacts about its development process (see chapter 5: Design Studies). They are considered as research projects, and without reflections, discoveries or insights through these projects, this study would not have been able to justify using properties of synaesthesia as creative approaches for idea generation. Design practice is

one of the essential motivations for this research as it enables the discovery of new viewpoints and debates. In this regard, this research attempts to consider one of Christopher Frayling's (1993) design research models, "research through art and design", as one of the main research methods in relation to creative practices.

The term "research through design" is widely used in various academic discourses. While the term may be interpreted as having different meanings, in design discipline, it conveys the meaning of "how design may be understood as a knowledge-generating activity" (Durrant, et al., 2015, p.9). The term was devised by Christopher Frayling, who adapted Herbert Read's work (1943) on art research, and it was influenced by Bruce Archer's work (1995) and Donald Schön (1983). Some data and information from the Allison index and the CNAA (Council for National Academic Awards) documents also encouraged his thoughts (Frayling, 1993, p.5). Frayling coined three approaches to art and design research. They are "research through art and design", "research into art and design" and "research for art and design" (Ibid.).

- **Research into design:** Where research activities and goals are to explore historical views and timeline, aesthetic or perceptual research and other theoretical perspectives on art and design from various archives.

- **Research for design:** Research where the final product is an artefact. Where the research is embodied in the artefact, where the goal of research is not verbally communicable knowledge, but rather visual or imagistic communication.

- **Research through design:** Where the research focuses on the process and development of creating artefacts.

This PhD primarily attempts to adopt "research through design" to situate or create a relationship between design practice and research, but also partly adopting the idea of "research for design" as the whole journey of this PhD research also encouraged me to improve various design projects. "Research into design" is also somewhat apt in a way as

this PhD research has explored and reviewed historical timelines of different creative practices that embraced the subject of synaesthesia.

Theory-rich design can be far more playful and engaging than just self-generated artistic practices by deeply understanding the world and people's issues (Friedman, 2003, pp.519-522). The study and attempt to understand humans through research will enable design researchers to generate insights that are far more meaningful. Thus, this PhD research adopted a practice-based research approach for the journey of generating new knowledge within the field of design.

4.6: Boundary Objects

Boundary objects are physical or abstract objects that are used to communicate ideas across different disciplines and reach a middle ground while discussing ideas, concepts and innovations. Boundary objects help to find a coherent and shared meaning between different disciplines and enrich the conversations (Balint and Pangaro, 2016). The theory of boundary objects was initially introduced by Susan Leigh Star and James Griesemer (1989) in a study of development of the Berkeley Museum of Vertebrate Zoology. The original article describes boundary objects as below:

- Scientific objects, which both inhabit several intersecting social worlds and satisfy the informational requirements of each of them
- Objects plastic enough to adapt to local needs and constraints of several parties employing them, yet robust enough to maintain a common identity across sites
- Weakly structured in common use, becoming strongly structured in individual site use
- Abstract or concrete
- Having different meanings in different social worlds but a structure common enough to more than one world to make them recognizable, a means of translation

Since it has been in a study on information practices at the Berkeley Museum of Vertebrate Zoology, various disciplines have adopted the idea in a broad range of research contexts (Huvila, et al., 2016, p.3). For example, it has been employed in management (Kuhn, 2002), archival science (Yeo, 2008), economics (Langenohl, 2008), education (Emad and Roth, 2009), design strategy (Stevens, 2013), document studies (Lund, 2009) and information science (Huvila, et al., 2016), among others.

Design as a discipline is ever increasing its spectrums with constant disruptions. It demands to engage with new collaborations, new technologies and a new context of social meanings (Johnson, et al., 2017; Bremner and Rodgers, 2013). In this context, boundary objects can be particularly useful in reaching beyond the boundaries, as they facilitate dialogues between disciplines to construct and negotiate meanings and values to broaden existing perspectives and paradigms (Balint and Pangaro, 2016; Johnson, et al., 2017). By incorporating the concept of boundary objects and crossing the streams between disciplines, understandings, literature and meanings, researchers will gain deeper and richer findings about information, practices, technology and artefacts (Huvila, et al., 2016, p.22).

This research explores an interdisciplinary subject as the nature of synaesthesia research associates and receives contributions from various disciplines. In this context, the entire design practices within this research are considered as boundary objects. This PhD research has been communicating with a diverse range of disciplines through different projects, from cognitive-neuroscience, design, engineering, medical science and fine art through project demonstrations to facilitate debates and feedback. The idea of boundary objects allowed this research to develop new meanings and ideas by sharing the concept of synaesthetic-provocation via projects and concerns (see chapter 5: Design Studies). This process of learning by sharing has contributed to the development of this research in terms of understanding how other people think of my research concerns and perspectives (see Appendices & section 5.3: Workshop & Expert Feedback). Therefore, this research adopts the concept of boundary objects as one of the research approaches by considering design projects as agents or correspondents for antidisciplinary white spaces (see section 4.3: Antidisciplinary Mindset within Interdisciplinary Subject).

4.7: Workshop & Toolkit

This research has used ideation workshops and toolkits to understand and evaluate some of the approaches of using synaesthesia as a provocation in generating creative ideas in design study. This participatory approach (see section 4.8: Participatory Design) tries to access participants' experience regarding the synaesthetic-provocation toolkit by listening, interpreting, watching, observing, uncovering and appreciating their feelings and imaginations to understand others' perspectives and tacit knowledge (Frascara, 2002; Polanyi, 1983). The toolkit and workshop (see section 5.2: Synaesthetic-Provocation Toolkits) were also inspired by the cultural probes technique, which tries to generate and provoke responsive dialogues with participants through tasks and tools (Gaver, Dunne and Pacenti, 1999). The cultural probes approach attempts to expand and deal with the limited understanding of knowledge by valuing uncertainty, play, exploration and subjective interpretations of people (Gaver, et al., 2004). The workshops process (see sections 5.2 and 5.3) was also somewhat motivated by three basic stages of participatory design method suggested by Spinuzzi (2005, p. 167). This foundation was then optimized through my experience of conducting workshops (see section 5.2.1.1: Why Cards?). Workshops have mainly covered the idea generation process as ideation workshops usually create certain outcomes that can be shared with other people. These shared outcomes are also potentially useful in terms of receiving feedback outside of the participants (see section 5.3: Workshop & Expert Feedback and Appendices). Conducting workshops is crucial in this PhD research as it links to some degree of validity and reliability of the approaches within qualitative-based research.

Designers go through the ideation process in order to conduct a project. This is fundamentally necessary in terms of discussing, expressing and refining multiple ideas for a project. In many cases, designers often work with a card-based tool when using the idea generation process. There are various tools and approaches that try to assist this ideation development. For example, IDEO's method card attempts to explore new perspective to inspire people by learning, looking, asking, and trying through a selection of fifty-one different cards and approaches (IDEO, 2003; 2013). Dan Lockton's Design with Intent (Lockton, 2016) provides a toolkit that shares eight lenses to think about

opportunities in design in relation to behavior change within social, environmental and cognitive (mind) contexts. A card deck by Golembewski and Selby has proposed a bespoke card-generating process that helps to deconstruct a project's concerns and issues for a specific ideation process (Golembewski and Selby, 2010). A famous decision-making method by Edward de Bono uses a six thinking hats¹³ role-playing context that allows people to discuss each point of view from different perspectives (de Bono, 1985; 1993). As such, many creative experts use toolkits as a method to provoke and inspire, and as a means to discuss concerns and ideas.

The concept of the toolkit is also one of the methods that I have adapted to articulate the provocative properties of synaesthesia for the ideation process. Particularly, the main reason behind adapting a tangible toolkit in relation to synaesthesia was to share the intangible properties of synaesthesia with people. This toolkit was important because, otherwise, the three discovered properties of synaesthesia would have been difficult to share with other people (see sections 5.1 and 5.2). As such, using a tangible toolkit to articulate intangible synaesthetic properties through a participatory workshop approach was a necessary choice in this PhD research.

4.8: Participatory Design

Participatory design is a widely known design approach in the realm of design. It had been around for nearly 40 years since its development in Scandinavia in the 1970s (Sanders and Stappers, 2012, pp. 28-30). It was initially established to improve the production of workers by engaging them in the development of new systems for the workplace in order to enable workers to develop realistic expectations in their working places. Participatory design is one of the approaches that tries to involve participants actively in the design process to help their demands through their experience and perspectives (Gregory,

¹³. Six Thinking Hats: http://www.debonogroup.com/six_thinking_hats.php

2003). Participatory design highly values participants' tacit knowledge and attempts to discover the invisible aspects or behaviours of human activities.

By trying to understand participants' experience-based knowledge through a variety of co-design methods and techniques, the approach assumes that the collective intelligence, experience and creativity from the participants can help design improve users' experience (Schuler and Namioka, 1993, p.130; Spinuzzi, 2005, p.164). Unlike traditional methods of user-centred design processes, where designers (experts) passively approach understanding users' experience and behavior through mere observation and analysis, in co-design, participants (users) play the main role in developing concepts and ideas and provide the position of expert of their own experience (Sanders and Stappers, 2008, pp.5-18). The term participatory design is widely used in a variety of disciplines from industrial design, architectural planning, user interface design, software engineering and, sometimes, even to contemporary art practice (Holt, 2015).

This participatory design aspect was employed in this research to find out the usefulness of the toolkit, and to understand the way in which the toolkit influences individuals' creativity in different ways. The feedback from the participants allowed this research to develop and update an improved toolkit that has better accessibility for participants (see section 5.3: Workshop & Expert Feedback). Therefore, participatory design was an essential approach that enabled this research to learn different aspects of the synaesthetic-provocation toolkit through participant studies.

5. DESIGN STUDIES

This chapter will answer the two research questions that have been set up throughout the literature review, by examining different design-research practices, toolkits and workshops:

[RQ1] How can the characteristics / properties of synaesthesia be used / applied to stimulate creative idea generation and debate?

[RQ2] What tools can be created to support these approaches / applications?

This chapter will first elaborate on one of the key research projects, Three Studies of Synaesthesia, through which three different properties and characteristics of synaesthesia were identified. These later inspired me to create three approaches of synaesthesia provocation and application for the idea generation process in various design studies. These approaches were then transformed to three different tools of idea generation and have been examined through various workshops by applying seven different themes in order to validate the usefulness of the discovered approaches through toolkits. The toolkits have been updated and re-designed based on the feedback I received throughout workshops. Following the discovered properties, approaches, toolkits and validations, this chapter brings experts feedback that helped to answer the research questions. This chapter will elaborate how each research project has contributed to the research questions. This chapter will cover eight design research projects, three approaches of application, three toolkits, seven themes and four workshops.

5.1: Three Studies of Synaesthesia

5.1.1: Property 1: Translation

5.1.1.1: Prop 1 – Project: Weight and Scale

5.1.1.2: What I Learned

5.1.1.3: How Does it Contribute to Research Questions?

5.1.2: Property 2: Narrative

5.1.2.1: Stories from Synaesthetes

5.1.2.2: Prop 2 – Project: Angry Red

5.1.2.3: What I Learned

5.1.2.4: How Does it Contribute to Research Questions?

5.1.3: Property 3: Mental Imagery

5.1.3.1: Prop 3 – Project: Drinking Electricity

5.1.3.2: What I Learned

5.1.3.3: How Does it Contribute to Research Questions?

5.2: Synaesthetic–Provocation Toolkits

5.2.1: Synaesthetic Translation Tool

5.2.1.1: Why Cards?

5.2.1.2: Card A

5.2.1.3: Card B

5.2.1.4: How Does it Contribute to Research Questions?

5.2.2: Synaesthetic Narrative Tool

5.2.2.1: Why Stories?

5.2.2.2: How Does it Contribute to Research Questions?

5.2.3: Synaesthetic Mental Imagery Tool

5.2.3.1: Why Sensory Prop?

5.2.3.2: How Does it Contribute to Research Questions?

5.3: Workshop & Expert Feedback

5.3.1: Workshop Audience & Why Workshop?

5.3.2: Themes / Tasks

5.3.2.1: How Does it Contribute to Research Questions?

5.3.3: Workshop: Royal College of Art

5.3.3.1: Ideas Discussion

5.3.3.2: Feedback & How Was It Useful?

5.3.3.3: How Does it Contribute to Research Questions?

5.3.4: Workshop: Carnegie Mellon University

5.3.4.1: Ideas Discussion

5.3.4.2: Feedback & How Was It Useful?

5.3.4.3: How Does it Contribute to Research Questions?

5.3.5: Workshop: Officer Cadet Han

5.3.5.1: Ideas Discussion

5.3.5.2: Feedback & How Was It Useful?

5.3.5.3: How Does it Contribute to Research Questions?

5.3.6: Feedback & Learning From Expert: Dr. Timothy Layden

5.3.7: Feedback & Learning From Expert: Dr. Richard Cytowic

5.3.8: Feedback & Learning From Expert Dr. Joel Salinas

5.1: Three Studies of Synaesthesia

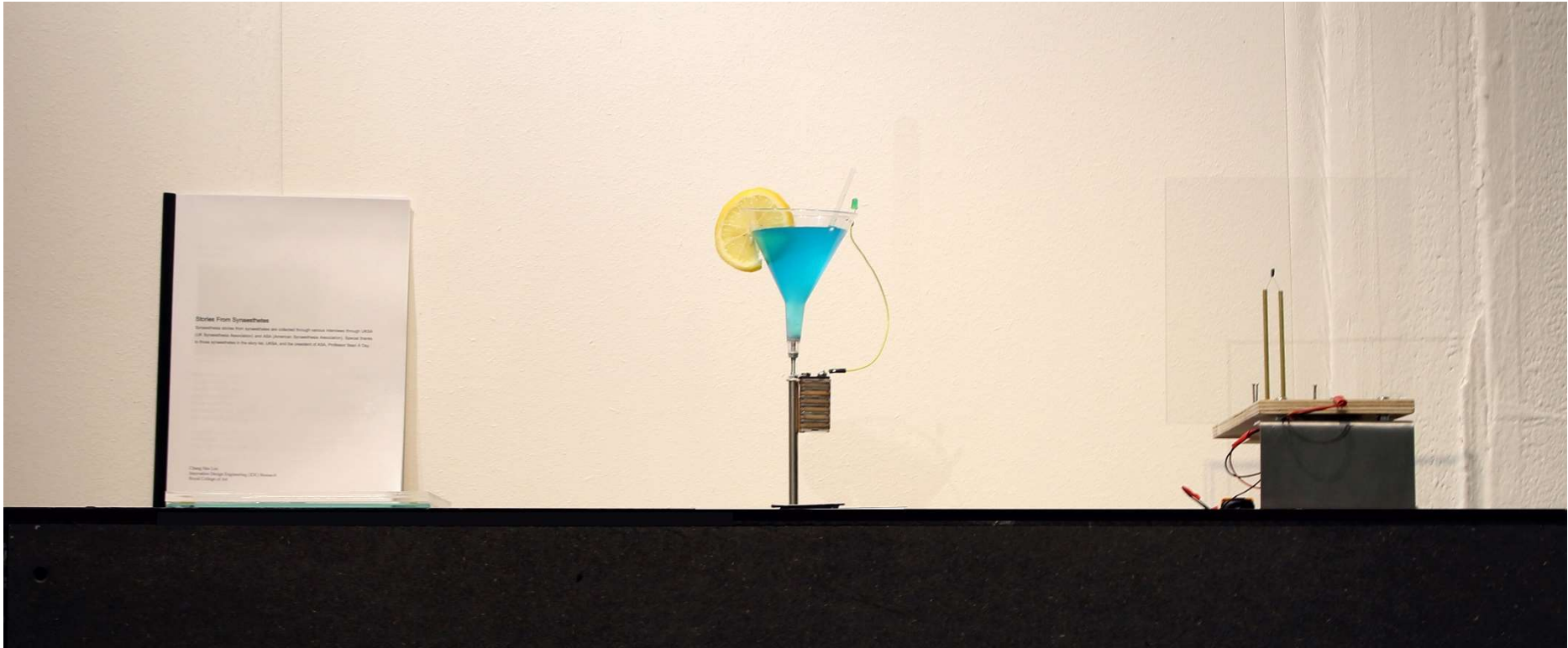


Figure.36 Three Studies of Synaesthesia

Three Studies of Synaesthesia (fig.36) is a research project that attempts to discover some of the intriguing properties and characteristics of synaesthesia. The project's aim was to understand the transcendental and creative quality of synaesthesia from a designer's point of view. By looking into relevant synaesthesia design practices and literature through my own interpretation, I was able to conduct this project to discover three different properties of synaesthesia in a creative context. For this project, I have generated a stepping stone question, "*What are some inspiring properties of synaesthesia that can be useful in design?*" in order to answer one of PhD research questions [RQ1]: "*How can the characteristics / properties of synaesthesia be used / applied to stimulate creative idea generation and debate?*" The two questions may look similar, but without the findings of three provocative properties of synaesthesia through this project, this research was not able to establish three approaches and a toolkit of applying the idea of synaesthesia as a provocation in design. (This will be discussed more in section 5.1.1.3: How Does It Contribute to Research Questions?) *Three Studies of Synaesthesia* comprises three design practices, which I also call the three props or pilot studies. Each prop highlights a provocative property of synaesthesia that I discovered while conducting this PhD research, and particularly throughout the literature review and in the interview I conducted with people about their experience of synaesthesia.

5.1.1: Property 1: Translation



Figure.37 Property 1: Translation

Throughout the literature and practice reviews, perhaps one of the most widely used approaches of synaesthesia application within a creative context is the translative or transformative approach of synaesthesia. These approaches could be summarised as the idea of material translation or experience transformation, which designers and many other creative practitioners appear to apply as the concept of synaesthesia (see section 3.2: Understanding Synaesthesia in Design). The meaning of material translation here is a transformation of one material to another (either tangible or intangible). For instance, the alphabet is perceived as colour, taste becomes smell and other more translative possibilities, according to different types of synaesthesia (fig.12 & 37). This feature has also been mentioned (but not as a property) by the Italian synaesthetic design researcher Dina Ricco (see section 3.2.6: Synaesthetic Design) as well as in the Digital Synaesthesia research project at the University of Applied Arts Vienna between 2013 and 2016 (see section 3.2.7: About Digital Synaesthesia). However, the difference between the idea of translation in this PhD research and their research is that this PhD research does not simply try to use the idea of translation into a creative practice, but explores and examines how this provocative property may be used as a source of inspiration. This will be discussed more in section 5.2: Synaesthetic-Provocation Toolkits and 5.3: Workshop & Expert Feedback.

5.1.1.1: Prop1 - Project: Weight and Scale

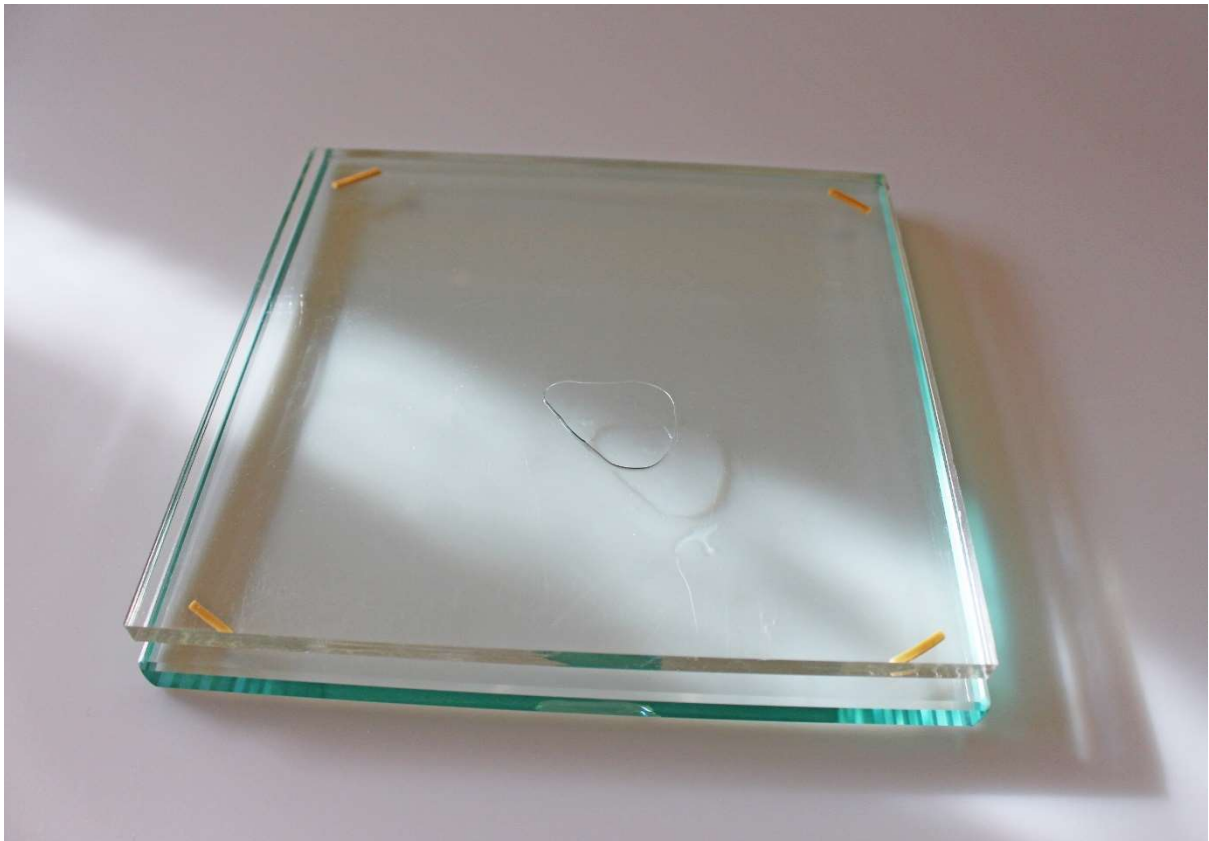
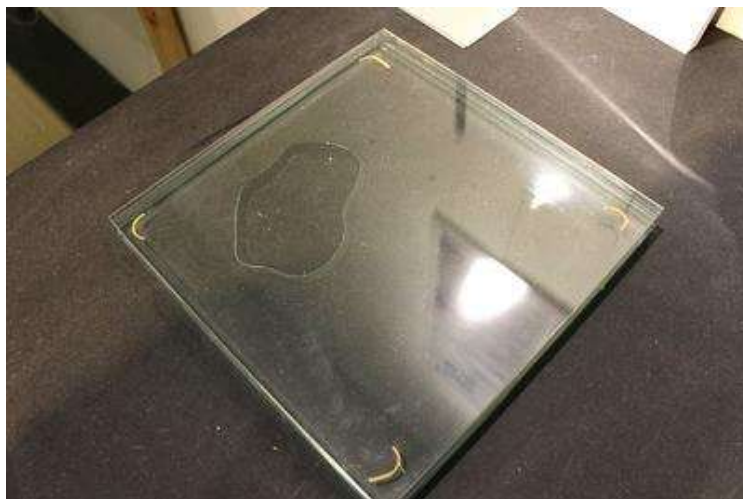


Figure.38 Prop 1 - Project: Weight and Scale



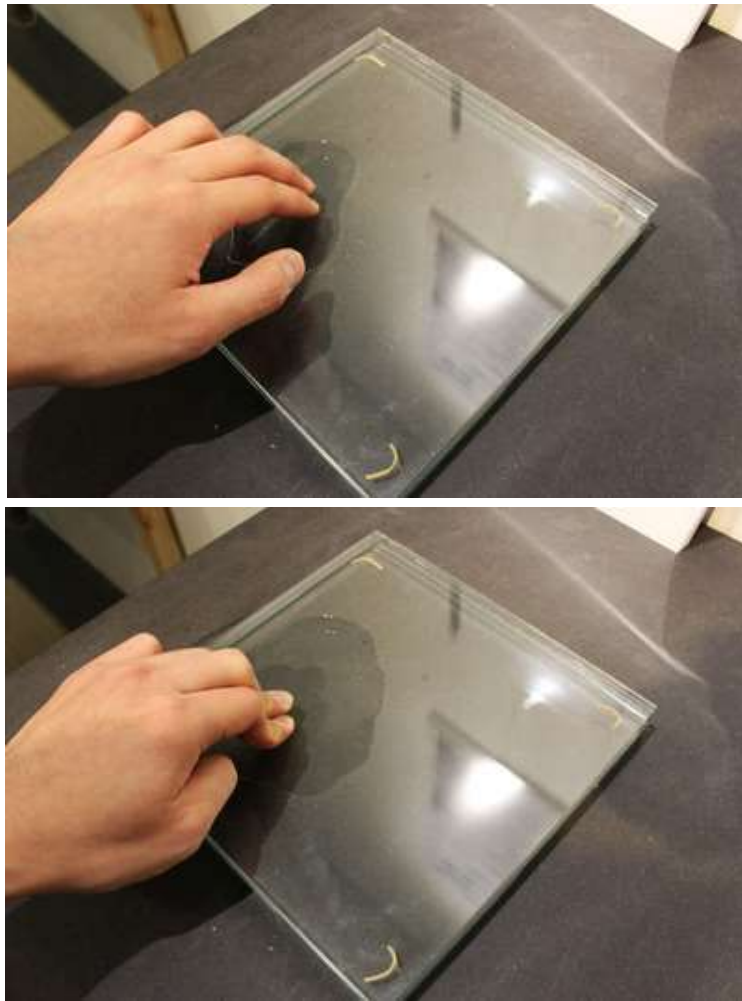


Figure.39 Prop 1 Demonstration

The translative property is perhaps one of the main provocative traits that lead designers to conceive different probabilities regarding synaesthesia application in their creative practices. Presumably, this is because the experience of synaesthesia itself is largely associated to the idea of sensory and experience translation, where a sensation in one of our senses, such as taste, triggers a sensation in another, such as hearing (Simner, 2012, pp.1-12).

A tangible example for describing the translative property of synaesthesia is a prop that I created while examining some of the intriguing elements of synaesthesia that can be implemented in design practices. In *Prop 1* (fig.38 & 39) the transparent structure studies and imitates the property of synaesthesia by considering how weight and scale could be associated with each other. The trapped or sealed liquid between the two glass sheets immediately expands its surface according to the pressure it receives on the glass surface.

This also creates changes in shape, depending on the area where the surface is being pressed. The heavier the weight or pressure, the more the surface expands.

The association between weight, scale and shape is not a type of synaesthesia. However, this prop was created to demonstrate the translative property of synaesthesia by associating those three properties. The translative property of synaesthesia offers opportunities to speculate different creations. This prop was one of several demonstrations, as well as a creation provoked by the translative property of synaesthesia. This prop also later gave a certain inspiration for *Prop 2* in terms of expressing aggressive behaviour (see section 5.1.2.2: Prop 2 - Project: Angry Red).

5.1.1.2: What I Learned

[1.] *Prop 1* has been listed in the List of Data Physicalizations and categorized and evaluated by them as a type of measuring instrument¹⁴. This list aims to help people to discover data using computer-supported physical data representations. This project bridged an idea between synaesthesia and data physicalization and led me to realise that the translative property of synaesthesia can provoke other creative dimensions and understandings (such as data physicalization). *Prop 1* directed me to explore whether this translative property can become an approach of applying the idea of synaesthesia as an inspiration source in a creative context.

[2.] *Prop 1* was cited in a human-computer interaction (HCI) conference (ACM CHI 2017) as one of the tentative examples for qualitative displays and interfaces¹⁵. Much of our response, experience and how we feel in the real world is qualitative rather than quantitative. This conference paper tried to explore opportunities for qualitative displays in data presentation to challenge the dominant platform of quantitative information

¹⁴ Info: <http://dataphys.org/list/turning-weight-into-scale>

¹⁵ Info: <https://dl.acm.org/citation.cfm?doid=3027063.3053165>

displays (Lockton, Ticketts, Chowdhury and Lee, 2017). This exposure of prop and the translative property of synaesthesia in the domain of HCI makes my claim stronger as the property brought an opportunity for different types of debate and creative aspiration beyond the subject of synaesthesia.

[3.] During my PhD research, I have organized a joint PhD symposium with an exhibition between the Royal College of Art (RCA) and the University of Oxford (see Appendix B: Crossing Over: The Art & Science of Multisensory Perception)¹⁶. One DPhil researcher, Alejandro Salgado Montejo from Crossmodal Research Laboratory, had a playful experience with this prop and another prop (Prop 3 – Angry Red) as he continuously pressed them with satisfaction and excitement. He commented that he wanted to “have it in their laboratory on a bigger scale” as he thought it was very playful and enticing. This feedback triggered me to conceive and adapt the concept of playfulness in relation to the translative property of synaesthesia. This learning later affected one of the themes that I used for the validation of my toolkit and approaches (see chapter 5.3.2: Themes / Tasks).

[4.] *Prop 1* also successfully mimics the experience of synaesthesia, as I have received feedback from a synaesthete through the UK Synaesthesia Association (UKSA) telling me that this prop similarly mimics her experience. (She saw the demonstration of this prop through ACM interaction magazine.)¹⁷

¹⁶ Info for the symposium: <https://www.rca.ac.uk/news-and-events/events/crossing-over-art-science-multisensory-perception/>

¹⁷ ACM interaction magazine: <http://interactions.acm.org/enter/view/demo-hour48/4>

5.1.1.3: How Does it Contribute to Research Questions?

Within the project *Three Studies of Synaesthesia, Prop 1* allows this research to approach towards my first research question **[RQ1]** “How can the characteristics / properties of synaesthesia be used / applied to stimulate creative idea generation and debate?” As I have articulated in the above chapter, the translative property of synaesthesia associates with various realms, such as HCI, data physicalisation, experience mimicry and playful components. By finding and sharing the potentials of the translative property of synaesthesia through a project, I was able to explore how this provocative property of synaesthesia may become a creative approach in design as well as in the idea generation process. The discovered property and learning became a stepping-stone for creating the translation tool within the synaesthetic-provocation toolkit, which links to **[RQ2]** “What tools can be created to support these approaches / applications?” (see section 5.2: Synaesthetic-Provocation Toolkits). Therefore, *Prop 1*, within the project *Three Studies of Synaesthesia*, has partly embraced and contributed to answering **[RQ1]**.

5.1.2: Property 2: Narrative

Synaesthesia research explores a variety of unusual experiences from different people. This is because synaesthesia is a distinct sensation for each individual. This means that investigating and analyzing stories from synaesthetes can be a useful way to understand their experience. Particularly, the narrative and the way they describe their experience is an intriguing avenue for designers to discover. In order to understand this better, I carried out an exploratory survey with synaesthetes to gain insight into their experiences. I aimed to find out:

- the types of synaesthesia that people experienced, explained through stories rather than the abstract descriptions found in various literature.
- the expressive aspects of people’s synaesthetic experience in detail.
- where these stories and narratives could inspire or be translated into practice.

5.1.2.1: Stories from Synaesthetes

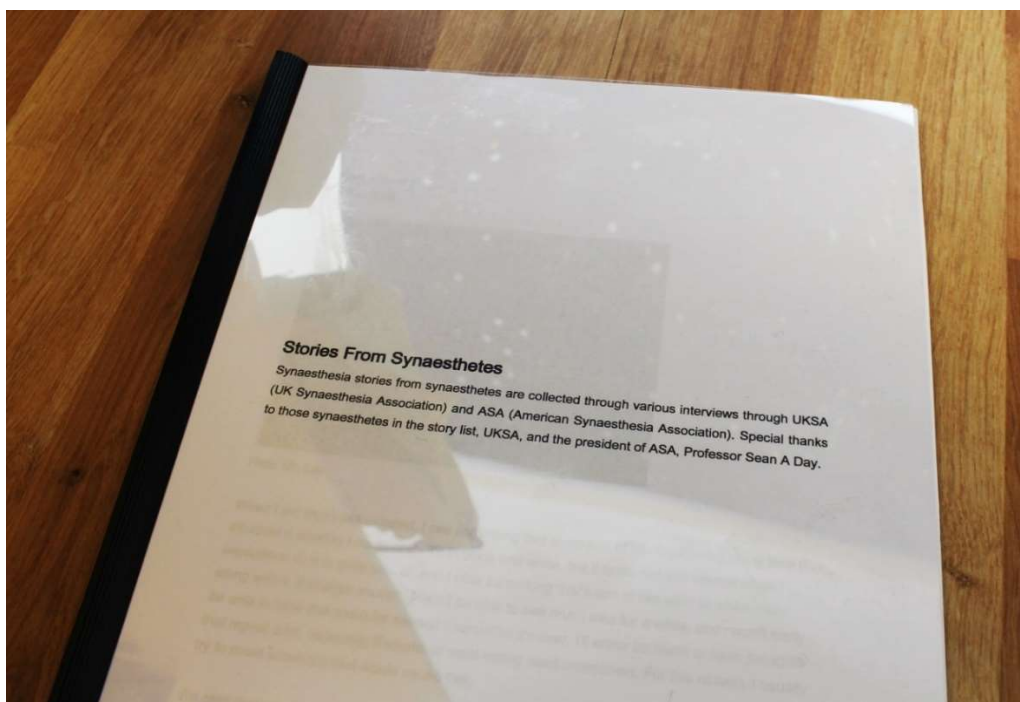


Figure.40 Stories from Synaesthetes

Throughout researching the topic of synaesthesia, I became a member of the UKSA as well as a member of the ASA (American Synaesthesia Association). The synaesthesia research community is still relatively small (Mulvenna, 2012, p.2), so from the two associations, I was able to get in touch with many different types of synaesthetes. By officially requesting synaesthetes' stories of experience through UKSA and ASA (through the president of ASA Sean A Day) from April to December in 2015, I have received a total of 15 different stories from people who experience synaesthesia (fig.40). Their backgrounds were diverse, ranging from a student, a journalist, a university lecturer, practising artist to a poet. According to earlier research by Ramachandran (Ramachandran and Hubbard, 2001a, p.15), synaesthetes experience a strong emotional reaction when they experience synaesthesia; and, in my research, this strong emotional response of synaesthesia was mostly found to lead synaesthetes to explain their experience in detail. Below are two of the stories (more stories are in the Appendix M), which show how they experience synaesthesia (the stories have not been changed or modified by myself for any purpose.



Figure.41 Cycling with Synaesthesia (work by Dr. Timothy Layden)

1. [From Dr. Timothy Layden] - (fig.41)

I have always experienced sounds as having shape, weight and texture. I like to listen to music filled with thick textures and shapes that move around me. When I go to concerts I love how big shapes appear that I can dance with.

When I'm out and about, shapes can distract me, stealing my attention from what is going on in the "real" world. This is usually very exciting but can sometimes be disconcerting or even dangerous. Once, as I was riding my bike, a bus put on its breaks right next to me. The screeching sounds threw a big shape around my head causing me to have to stop in my tracks.

Some years ago I began hunting sound shapes. I capture them with a recorder and take them home where I put them in soundscapes with other shapes, which I draw and paint.

The watercolour painting and the sculpture (fig.41) are by Dr. Timothy Layden (PhD in Fine Art), who is a practising artist who experiences sound-shape, weight and texture related synaesthesia. Timothy painted the image at my request, as, at that time, I wanted to organize a curatorial project at the beginning of this PhD. Although the curatorial project did not come to fruition, thankfully, Timothy still completed and shared his painting and sculpture of his own synaesthetic experience. Timothy seems to experience a strong texture alteration depending on the sounds he perceives, as the painting and sculpture appear to emphasize the quality and texture of a "dark thing" quite powerfully (where, for me, it looks like an unknown black aura or unpleasant energy).

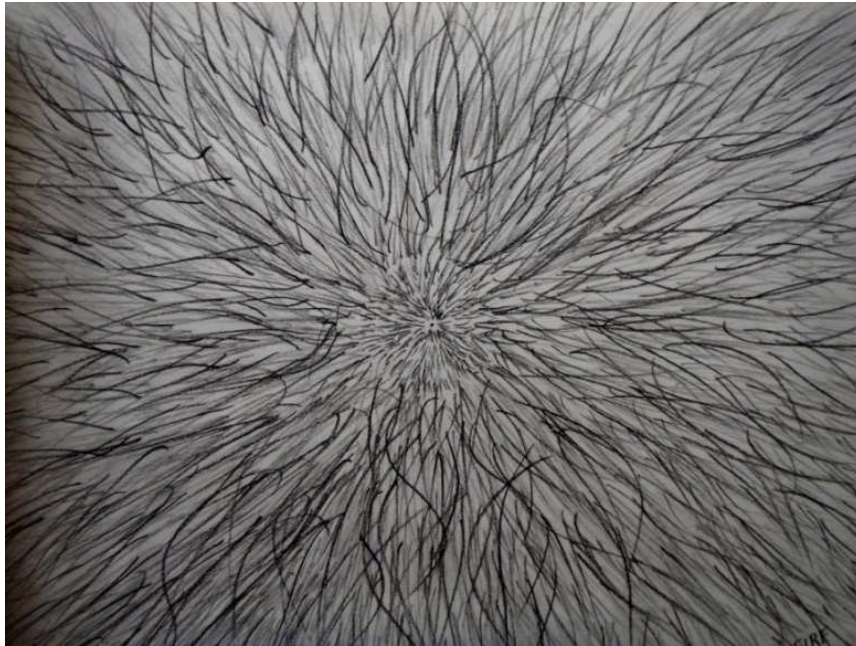


Figure.42 Sketch of Anger Related Synaesthesia by LG

2. [From LG] - (fig.42)

Hello Mr. Lee,

When I am angry or frustrated, I see something that looks sort of like fire coming at my face (I've attached a drawing I made of it - it's in black and white, but it looks red and orange when I experience it). It is quite painful, and I hear something that's sort of like wind or white noise along with it. If intense enough, I won't be able to see much else for a while, and I won't really be able to think that much for several hours after it's over. I'll either be blank or have thoughts that repeat a lot; especially if whatever went wrong went unresolved. For this reason, I usually try to avoid situations that would cause this.

I'm glad that you are researching this - I've been wanting to contact a researcher about it for a while now (so I can understand it fully, and maybe get an MRI done or something), but I don't really know if inducing something like this for a study would be seen as ethical.

I hope this helps,
-LG.

Briefly put, in Luke's story, whenever he feels angry or frustrated, he sees orange and red fire effects coming over his face and hears a sort of wind or "white sound". He might not be able to see much for a while when the anger gets too intense.

5.1.2.2: Prop 2 – Project: Angry Red

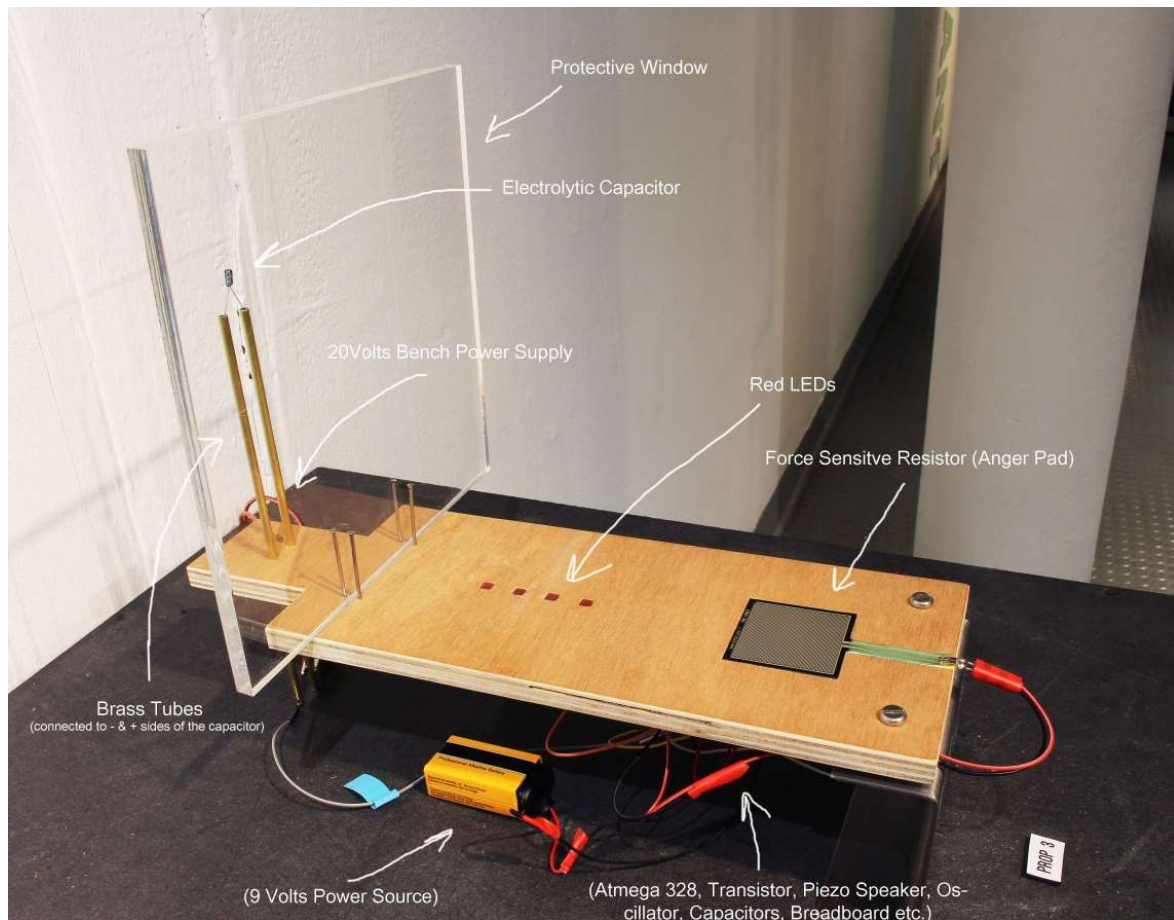


Figure.43 Prop 2 - Project: Angry Red

During the correspondence with LG, I was experiencing a strong depression, was not able to concentrate on my everyday lifecycle and felt pessimistic for numerous reasons. This mental atmosphere rather eccentrically encouraged me to adapt LG's narrative and mimic his experience into my creative practice, which seems to be one way of studying a method of materialising the experience of synaesthesia, as well as experimenting with unusual approaches to seek radical potentials in design practice. So, I designed and constructed a piece, *Prop 2*, initially called project *Angry-Red* (fig.43), which was inspired by LG's narrative of anger related synaesthesia¹⁸. *Prop 2* was an experimentation of mapping synaesthetic associations between red, anger, intensity, sound and explosion, as well as looking into the metaphorical links in between while speculating on how

¹⁸. Project Video link: <https://www.youtube.com/watch?v=zbq37Cc-yO4>

synaesthesia can be implemented and materialized within the context of design through materialising its narratives¹⁹.

By pressing the pad and expressing your amount of anger, it will turn one of four red lights and create a pitch of sound according to the pressure it receives. The red lights indicate that you have successfully loaded or transferred your degree of anger, which I tried to express Luke's intensity of anger. If the anger exceeds the level of the four lights and the pitch of sound becomes too intense, the box will self-destruct by burning itself out due to the overload of anger. (However, due to my awareness of the safety issues, especially regarding exhibitions, a capacitor is destroyed rather than the apparatus itself.)

One may consider that *Prop 2* was perhaps a rather strange, somehow useless or ambiguous project. However, as an experimentation of mapping synaesthetic associations between red, anger, intensity, sound and explosion, while speculating on how the narrative of synaesthesia could be implemented and materialized within the context of design, I believe it was successful.

5.1.2.3: What I Learned

[1.] Materialising the narrative of synaesthesia is a completely new trial and approach concerning synaesthesia application. While working on *Prop 2* through a narrative, I questioned what potential insights could we learn from synaesthesia narrative materialisation. The approach involves concepts such as tangible experience or data-artifact (as narrative has been translated into a tangible creative practice), and such an approach may instigate a new study and feasibility regarding synaesthesia application within the context of design.

¹⁹ Many scientists argue that the association between the colour red, aggression and danger might be connected to our evolution from ancestral hunter-gatherer times, which link red with danger and threats (signifies wounds and blood) (Dobson, 2014).

[2.] I was invited to exhibit one of my projects, *Three Studies of Synaesthesia*, at the Rebecca Hossack Gallery for the Open Senses Festival in 2017²⁰. At the exhibition space, I was able to meet Dr. RK, a visitor who has a PhD in Medicine Field of Neuroscience, with his partner. They were especially interested in interacting with *Prop 2* as the pad generated a pitch of sound according to the pressure it receives, and Rozelle's partner, who is a musician, was playing with the sounds by pressing and releasing the pad as if she were playing a violin. I was intrigued by their unusual interactions and approached them for a conversation. They were discussing this sound and LED mapping in relation to autism, and told me that this sound-mapping element can become an educational tool for people with autism. Although we did not discuss anything further regarding this idea, I was able to learn that the property of narrative can become an inspirational source for idea generation outside the subject of synaesthesia. We have exchanged our email addresses and agreed to have further conversation in the near future.

[3.] Audiences who participated in the experience of this materialized narrative (*Prop 2*) told me the prop surprised them, as the explosion of a capacitor behind the protection window creates a loud bang and smoke. Most people had smiles on their face and an expression of excitement²¹. Their reactions gave me tacit confirmation that the narrative materialisation can be one of the approaches of applying the idea of synaesthesia as a provocation.

5.1.2.4: How Does it Contribute to the Research Questions?

Prop 2, a materialised narrative within the project *Three Studies of Synaesthesia*, allows this PhD research to approach towards [RQ1] "How can the characteristics / properties of synaesthesia be used / applied to stimulate creative idea generation and debate?" By

²⁰. <http://opensenses.squarespace.com/2017-programme/2017/5/20/three-studies-of-synaesthesia>

²¹. Audience at the ASA National Conference 2017 at Harvard University also enjoys the prop 2 – Link: https://www.youtube.com/watch?v=LERigs58_M4 (see between 8:37 – 9:43)

successfully experimenting whether story and narrative could inspire or be translated into creative practice, I was able to learn from other people that the property of synaesthetic narrative and story can potentially be useful in generating different creative debates (see chapter 5.1.2.3: What I Learned). In a similar way to *Prop 1* (translative property), *Prop 2* allowed me to discover the property of synaesthetic narrative and became a stepping stone for conceiving the toolkit and approaches of applying the idea of synaesthesia as an inspiration in design. Thus, *Prop 2*, within the project *Three Studies of Synaesthesia*, has contributed to answering **[RQ1]**.

5.1.3: Property 3: Mental Imagery

Individuals' experience of synaesthesia and the narratives they produce have a unique texture of mental imagery. Thus, the quality of mental imagery is one of the foundational properties of synaesthesia, regardless of the specific types of synaesthesia.

By interviewing different synaesthetes (see chapter 5.1.2: Property 2: Narrative) and examining various provocative stories, I began to gain interest in the idea of mental imagery and its potential creative implementations. Exploring people's mental imagery through their stories and interviews is like discovering one's private world. Below I share a project that tries to experiment by using the property of the mental imagery of synaesthesia for shaping a creative practice.

This was to learn ideas around:

- whether the quality of synaesthetic mental imagery may be useful in generating creative practice.
- receiving feedback from other people by sharing this research project and my understanding.
- experimenting with unusual ways of generating design practice to gain unusual insights for further research opportunities.

5.1.3.1: Prop 3 – Project: Drinking Electricity



Figure.44 Prop 3 - Project: Drinking Electricity

Prop 3 (fig.44) is another artefact within the project *Three Studies of Synaesthesia*. This project was planned to explore the taste of things that are impossible to savour or consume (things like rocks, soap, lasers, etc) in order to intrigue people through their experience²². The idea somehow brought me to conceive of the idea of tasting energy, or electricity — how does electricity taste in a synaesthete’s mind? What does it ‘really’ taste like? *Prop 3* aims to study and investigate the difference between the real and the surreal. This project began by asking a question of how the word “electricity” tastes to a lexemes-flavours synaesthete through Sean A Day’s synaesthesia mailing list.

²². Book: *Drawing Energy: Exploring Perceptions of The Invisible* (Bowden, et al. 2015) shows and illustrates many examples of how people perceive the concept of energy. (<http://www.drawingenergy.com>)

[From: K]
17.Feb.2016

Hi, Chang,

So, 'electricity' is one of those words that is very thin in consistency – like putting a sheet of paper in your mouth with the taste on it – a little hard to get, and a little... unsatisfying.... because you know the taste is there but you can't quite get the full sensation because the consistency is so 'thin'. A good analogy maybe is wanting to eat ice cream or something rich but only being able to lick an ice-cream flavored piece of paper A lot of words are like that actually. (Off the top of my head, Lindsay, and Linda are a couple of names like that – Lindsey with an 'e' is even thinner, I think because it doesn't have that voluptuous 'a' in it to round it up). An 'l' a hard 'c' or an 'i' in word – depending on placement and combination with other letters – tends to make it thinner. I'm really visual (apparently there is something called 'ticker tape' synesthesia, which I never knew was a 'thing', but to the degree it is, I evidently have it). I 'see' everything said or heard in writing, so the spelling and letters can make a difference in how a word tastes.

Breaking it down, the first two syllables, 'ele' if taken alone, are deliciously vanilla whipped-cream full and satisfying (the vowels 'a' and 'e' usually do that, give a fluffy and full consistency). But as soon as the 'c' gets in there – which tends to harden things up a lot – that all dissipates. The 'tricity' part dominates the fluffy whipped cream part (not sure why? Maybe because there is more of it) and it is thin and hard to grasp ... like water. A 't' often makes a word thin too. (But sometimes 'th', especially after an 'a', makes it really fluffy).

The overall effect is like drinking soda water. The thin consistency and the pingy bubbles (that kind of give it a little body, maybe as a nod to the full 'ele' syllables?) do this, but so does the fact that the word disperses all over the inside of the mouth (oh, I also feel different words in specific places in my mouth) – like water, but still has definite sensation (the bubbles) more than definite taste.

As an aside, the last name of Dr. Richard Cytowic also tastes like soda water. (I told him this years ago, when I was corresponding with him on his work!) The bubbles in his name are much more pronounced, however – it is, like, all zingy bubbles. When I examine that, I'm thinking it must be because of all the hard letters in both words, but his lacks a softening vowel, as the word 'electricity' does not. And, I'm thinking (but I'll have to give this some more thought, never paid attention before) that it might well be the 't' in both words that is so responsible for the zingy, active sensation that makes me equate it with carbonated bubbles. 'T' is generally a very pleasant and refreshing letter in a word, very green-tasting. (I know I just said that, but I'm not really a color-related synesthete, at least not that I've ever identified with).

Anyway, I hope that helps.

I would be happy to elaborate if you need.

Best,

K

Figure.45 What Does The Word “Electricity” Taste Like?

K is one of the synaesthetes who experiences lexemes-flavours synaesthesia. This synaesthesia evokes one to experience a word, as a whole unit, as a flavour. This does not mean, however, that this synaesthesia is merely describing how, for example, the word “pizza” makes you imagine or think of the flavour of pizza; people with this form of synaesthesia can literally taste the word in their mouth, in precise detail (Day, 2016, p.58). K’s written account (fig. 45) of the taste of the word “electricity” describes her experience in great detail, even though she did not taste real electricity.



Figure.46 Simplified Version of Prop 3 for Everyone

Prop 3 (fig.44) is designed to hold a modified nine-volt battery and allows people to experience the taste of electricity. The liquid (alcohol, salt and power drinks) inside the cocktail contains electrolytes that enable electricity to flow through the liquid and turn on the LED. The liquid here works as a resistor, so the nine volts from the battery will not destroy the LED, but it will provide a small shock on one’s tongue. In order to allow all people to access the experience of tasting electricity, I had to prepare many simplified versions like the one shown in figure 46. Many participants throughout my research have

tried the taste. Two people commented that the electricity tasted slightly salty on their tongue after they had compared the taste of liquid with and without the nine-volt battery. One participant seemed disturbed by the taste and developed a frown on her forehead, while another participant did not feel any taste on his tongue. The concept of mental imagery is one of the key properties of synaesthesia. This intangible asset may aid and facilitate creative discussion and provocation within the context of design.

5.1.3.2: What I Learned

[1.] By comparing the difference between the mental image and the real experience of taste, I was able to learn how our mental imagery process is comparably different to reality. This understanding gave me an opportunity to think about an approach of applying this property in design study.

[2.] I was not very confident using this property as one of the approaches of applying synaesthetic-provocation because of the relatively large sphere of the context of mental imagery. Besides, I learned that I was sceptical about this property due to the lack of useful feedback from public engagements, symposiums and conferences.

[3.] I was invited by Cindy Regalado, who was a PhD researcher in Engineering Science at University College of London (UCL), to participate in Doing It Together Science (DITOs), a talk and an exhibition, together with Waag Society, MediaLab Prado and Bioscope²³ (see Appendix D: Science has no Borders). One of the memorable pieces of feedback I received from the children and their parents during the exhibition was that they enjoyed the design of the cocktail itself instead of the context of synaesthetic mental imagery. They thought the cocktail's aluminum structure was fancy, with its blue-coloured liquid filling the inside with a green LED in the transparent structure. This somewhat inconvenient experience or

²³. Doing it Together Science (DITOs) website: <http://togetherscience.eu/>

learning (as they did not or did not want to understand the property of synaesthesia) led me to reconsider the quality of mental imagery as one of the approaches of using the idea of synaesthesia. (However, this PhD research later re-adopted the property of mental imagery as one of the tools for synaesthetic-provocation toolkit. See chapter 5.2.3: Synaesthetic Mental Imagery Tool)

5.1.3.3: How Does it Contribute to the Research Questions?

Prop 3 was an experiment through discovered synaesthetic property (mental imagery). It tried to explore the idea of mental imagery in relation to synaesthesia. By discovering the property of mental imagery, *Prop 3* provided a useful foundation for answering **[RQ1]** “How can the characteristics / properties of synaesthesia be used / applied to stimulate creative idea generation and debate?” This is because the discovered property of synaesthetic mental imagery later inspired some of the tools for applying this property in various design studies. Therefore, the discovery of this property and project has partially accomplished answering **[RQ1]**.

5.2: Synaesthetic-Provocation Toolkits

Throughout my time exploring and learning about the different properties of synaesthesia via projects, public engagement, symposiums, talks, a research paper and feedback, I decided to use these three properties of synaesthesia as approaches to applying the idea of synaesthesia for the ideation process. This is because I found these synaesthetic properties could potentially evoke creative debates that will encourage the generation of ideas in relation to broad disciplines and audiences (see sections 5.1: Three Studies of Synaesthesia & Appendices).

Synaesthetic-provocation toolkits were developed while considering the issue of how the discovered properties of synaesthesia can be practically implemented in creative studies. These synaesthetic-provocation toolkits were designed to contribute answers to both

[RQ1] “How can the characteristics / properties of synaesthesia be used / applied to stimulate creative idea generation and debate?” and **[RQ2]** “What tools can be created to support these approaches / applications?” through sharing the development of the toolkit and workshop contents. This section presents three synaesthetic provocation tools that convey three properties of synaesthesia: translation, narrative and mental imagery.

Although I have already addressed the idea of synaesthetic-provocation briefly in this thesis in different chapters—describing it as a way of stimulating inspiration using different properties of synaesthesia—I would like to clarify the term and the relationship with the toolkit before I further elaborate the sections.

Synaesthetic-Provocation

The term synaesthetic-provocation is about the idea of inspiring people through different properties or characteristics of synaesthesia. By different properties of synaesthesia, I mean, for example, the translative property can be one of the properties of synaesthesia (see section 5.1.1: Property 1: Translation). Synaesthetic-provocation is about the idea of how different properties of synaesthesia can inspire people. The synaesthetic-provocation toolkit is a tangible conveyer that allows people to communicate with the intangible properties of synaesthesia as a source of inspiration.

5.2.1: Synaesthetic Translation Tool

The synaesthetic translation tool (card) within the synaesthetic-provocation toolkits allows users to apply the provocative quality of synaesthetic translation practically in generating creative ideas. The idea of the translation tool was conceived while I was conducting the literature review and the project *Three Studies of Synaesthesia* (see sections 3.2.3: Synaesthetic Inputs in Different Contexts & 5.1.1.1: Prop 1 - Project: Weight and Scale). There are two different versions for this card. Card-A was the first version that I made for my first workshop at the Royal College of Art (RCA), London in 2016. The second

version of the translation toolkit, card-B, is an adapted version made after considering and evaluating feedback from participants in the first workshop (see section 5.3.3.2: Feedback & How was it Useful?).

5.2.1.1: Why Cards?



Figure.47 Card Tool

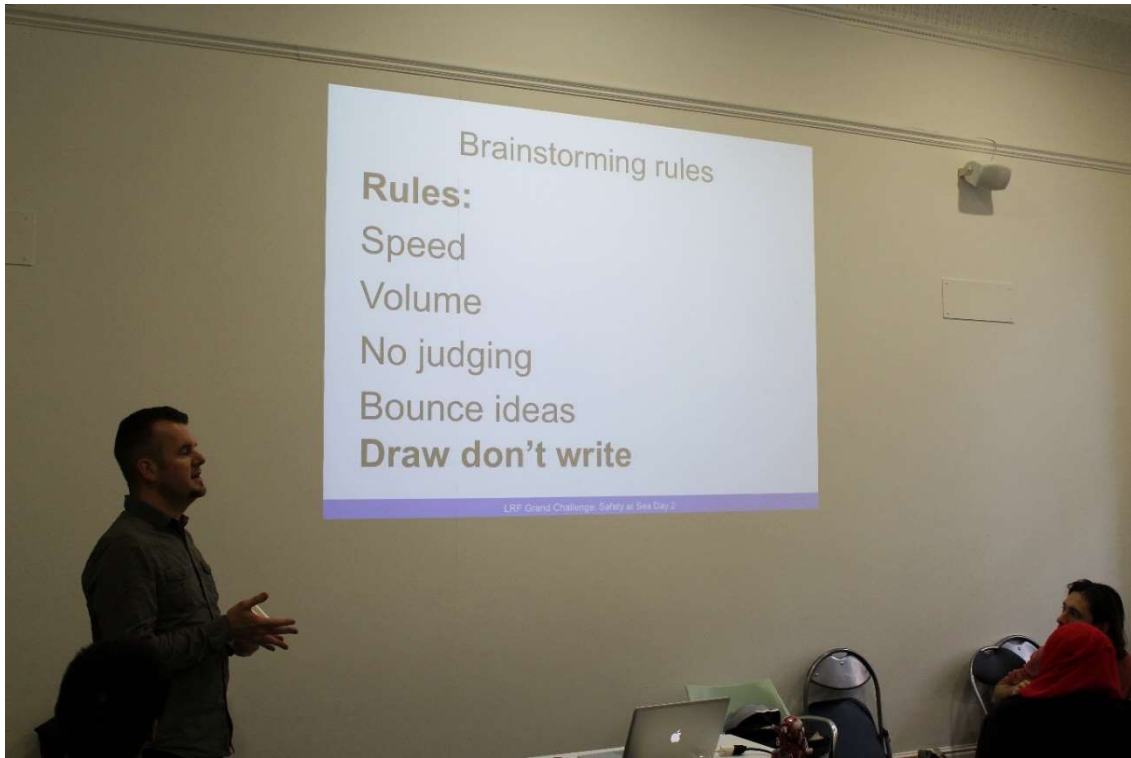


Figure.48 Brainstorming Session



Figure.49 Using Cards for Idea Generation

The reason that I have chosen to adopt the use of cards for this translation tool was based on my personal experience of helping to run workshops for a research project for postgraduate students at the Royal College of Art between September 2016 and March in 2017²⁴. One of the themes during the workshop was to brainstorm around one thousand different, quick ideas regarding safety issues using a card tool (fig.47, 48 & 49) in less than an hour (eight groups of students). During this brainstorming process, I had an opportunity to examine the way that students used the provided cards, as my role for this workshop was to record and capture this idea generation process using a DSLR camera. I was particularly fascinated by how simple cards can rapidly provoke and progress a variety of ideas generation. Edward De Bono, who pushed the boundary of lateral thinking, said that “simple methods used effectively are more valuable than complicated methods that are difficult to understand and confusing to use” (De Bono, 1985, p. 6) (see section 4.7: Workshop & Toolkit). By experiencing the usage of this simple method and the dynamic environment of the ideas generation process, I began to consider and acknowledge the usefulness of cards as one of the potential tools for practically applying the translative property of synaesthesia in design study. I was also partly influenced by one of my supervisor’s, Dr. Dan Lockton, toolkit cards, in which the toolkit aims to influence the users’ behaviour through design by giving the practitioners more nuanced approach to design and behaviour²⁵. The idea of using tangible cards to stimulate the ideation process for people was a result of seeking a way of using the intangible property of synaesthesia practically (see also 3.1.6: Synaesthesia and Creativity).

²⁴ . LRF Grand Challenge Project: <https://www.rca.ac.uk/news-and-events/press-releases/royal-college-art-tackles-dangers-ship-boarding/>

²⁵ . Design with Intent: <http://designwithintent.co.uk/introduction-to-the-design-with-intent-toolkit/>

5.2.1.2: Card-A



Figure.50 Synaesthetic Translation Toolkit – Card A

The translation card-A contains fifty translative possibilities, and people can use them to speculate different ideas for brainstorming purposes. Although some of the synaesthetic provocation cards directly employ the types of synaesthesia (fig.12) by embracing translative concepts, such as sound to vision, smell to colour and taste to sound, the fifty cards are not entirely based on the list of types of synaesthesia. As can be seen (fig.50), concepts such as pain to sound, energy to shape or pain to weight are not existing forms of synaesthesia. The reason I have used these types of synaesthesia into the translation card is due to my interpretation regarding the provocative qualities of synaesthesia in a creative context. Through the process of interviewing and exploring synaesthetes' experience via different associations (ASA, UKSA and synaesthesia mailing list) over the past years, I have found the way in which synaesthetes express (verbally and written) their experiences and embrace various imaginative scenes with their own interpretations and explanations (such as seeing energy like orbs through the experience of synaesthesia). Thus, some of the cards reflect my own interpretation regarding their imaginative scenes

on the experience of synaesthesia. I have reinterpreted the types of synaesthesia into subcategories when designing this card. For example, on card version A, one of the original types of synaesthesia, “sound-vision synaesthesia,” is explored as a sound to shape card, sound to speed card, sound to motion card and so on. I used these terms in order to interpret the concept of vision as shape, motion, speed and so on. I deemed this necessary because the ordinary list of synaesthesia limits the provocative quality of synaesthesia; thus, the cards needed more enhanced and developed information regarding the experience of synaesthesia for better creative user engagements and experience.

The less articulated scientific research regarding the bi-directionality of synaesthesia (see section 3.1.7: Redefining Synaesthesia?) was also adopted in this toolkit as it can potentially embrace much broader concepts for better creative discussions and lateral thinking (For example, the energy to sound card could be reversed and used as a sound to energy card.). Card-A was the first translation tool that I designed to share the synaesthetic translative approach with people in order to facilitate creative debates and the ideas generation process.

HOW TO USE CARD-A:

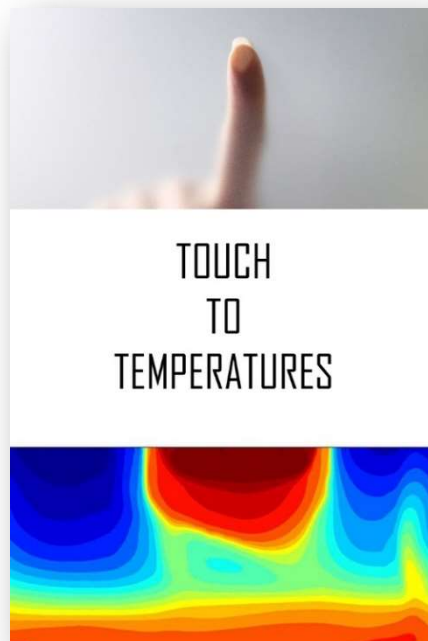


Figure.51 Touch to Temperatures Card – Card A



Figure.52 Motion to Sound Card – Card A

There are two ways to use the card-A tool (synaesthetic translation tool):

1. Translation Based on Cards:

Participants can just pick a card and use the phrase as inspiration. So, for example, the touch to temperature card (fig.51) can be interpreted as a way of translation: so the touch (idea of tactility, surface, solidity etc.) can be translated to temperature (idea of heat, weather, intensity etc.).

2. Literal & Figurative & Semiotic Usage

This card can be used any way the participants wish. For example, the motion to sound card (fig.52) does not have to follow the translation approach. In other words, motion does not have to be mapped to sound or vice versa, but can be used as provocation itself. So, if necessary, participants can consider motion as motion and sound as sound to stimulate creative thoughts without relating them together. This flexibility is designed to encourage more lateral thinking and creative debates.



ANGER



COLOUR



ENERGY

ABCDEFGHIJK
LMNOPQRSTU
VWXYZ

GRAPHEMES



MOTION

بلجیہ
België Россия
新加坡 日本
Србија رسم
Česká România

NAME



NOSE



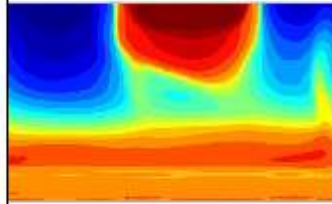
ORGASM



PAIN



TIME UNITS



TEMPERATURE



TASTE



STRESS



PERSONALITIES



SPEED



TOUCH



QUALITY



SOUND

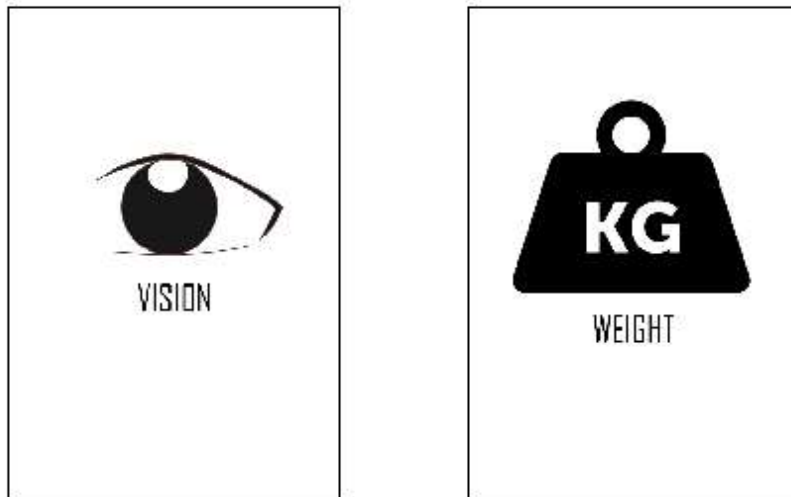


Figure.54 Synaesthetic Translation Tool – Card-B

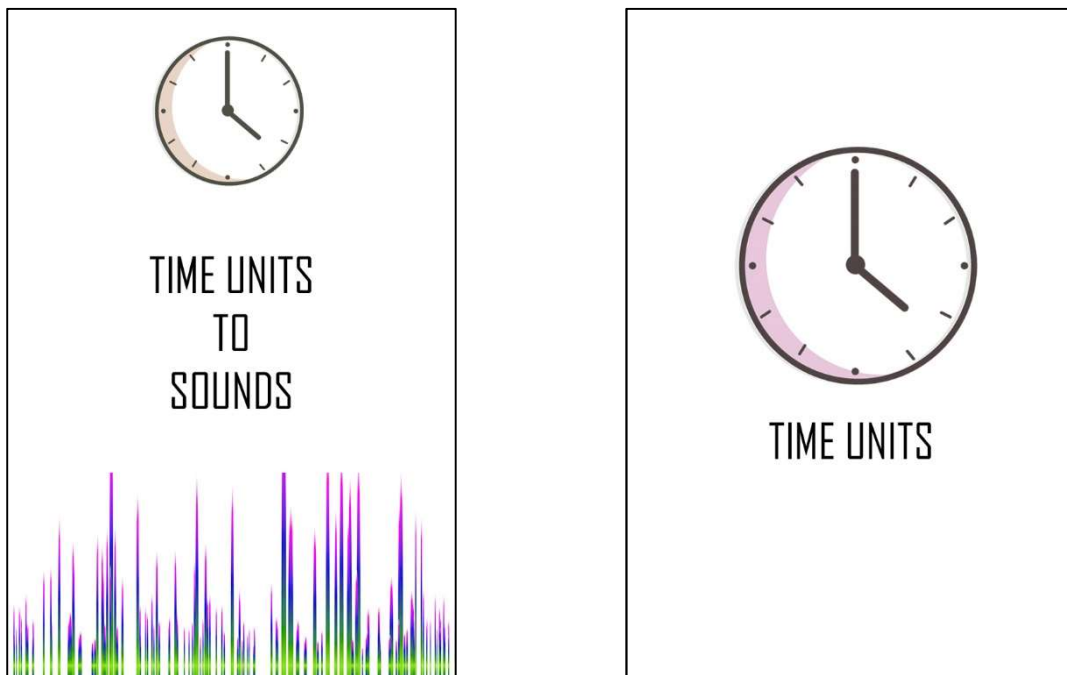


Figure.55 Differences Between Card-A (left) and Card-B (right)

HOW TO USE CARD-B:

1. Free Combination:

Card-B has a total of twenty different cards (fig,54). Each participant can have all twenty cards on their table and could speculate, stimulate and play their thoughts through any combination of the selected cards. Participants can combine the cards randomly or intentionally, from one card to another, to gain creative insights for their idea development. For example, combining the sound card with the weight card means sound can be translated to weight. Combining the pain card to the energy card means pain can be transformed to energy. This rather interactive component of card-B gives an engaging experience to participants. In total, card-B allows the user to think and build concepts through around 350 different combinations. Card-B retains the possibility of card-A to be reversed (bi-directional).

As I have mentioned above, each card can be interpreted to a different concept, so the touch card can be considered as the idea of tactility, surface, feeling and so on. Some cards may look similar, such as the pain card and the anger card, but the related concepts may be different. For example, both the pain and the stress card may be associated to ideas of anger, negative experience or heightened emotion, but the stress card might be less likely to be associated with the concept of bleeding, broken legs or a car accident than the pain card.

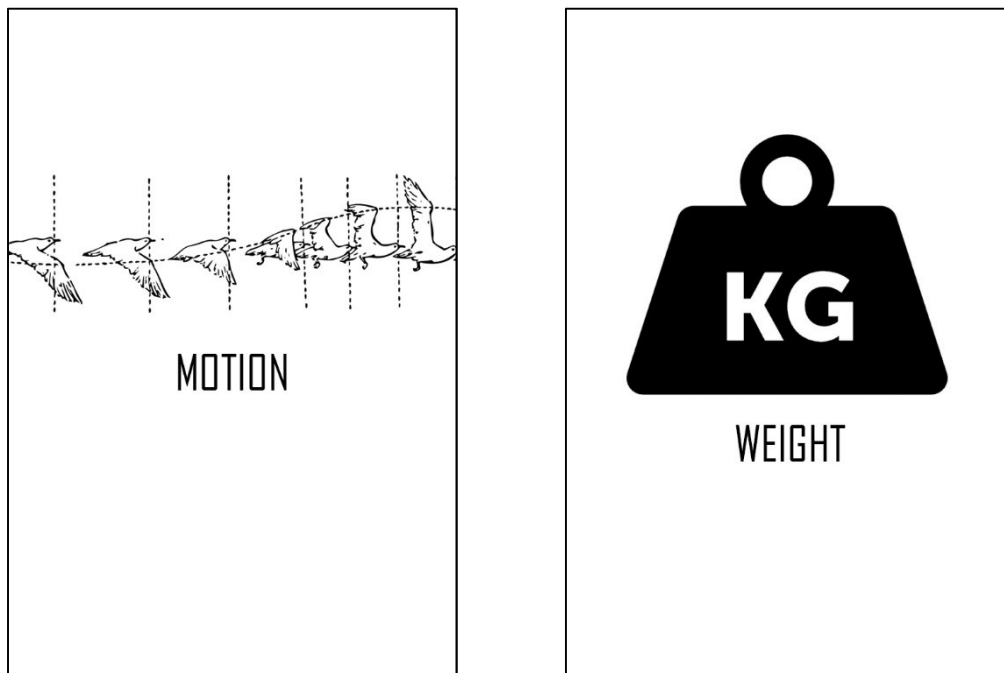


Figure.56 Literal Usage

2. Literal & Figurative & Semiotic Usage

An individual card can be used literally as the card itself. For example, one of the participants, who was a British officer cadet, participated in the workshop to generate ideas with the theme, “You are a military weapons designer. Design any military weapon and scenario that helps a nation’s military defence (NOT offence).” By looking into both the motion and the weight card (fig.56), he simultaneously thought of the tragedy of the Bastille day celebrations (Nice terror truck attack²⁶) and a concrete barrier design that stops a truck size vehicle (see chapter: 5.3.5: Workshop: Officer RH). He thought the image on the weight card (fig.56) looked like a strong solid structure that can block or stop any powerful thing. He then literally associated it to the Nice terror attack. Each card does not always have to be combined for translation purposes, but can be used as a foundation for triggering debates, semiotics and concepts.

²⁶. Nice Terror Attack: <https://www.theguardian.com/world/live/2016/jul/14/nice-bastille-day-france-attack-promenade-des-anglais-vehicle>

5.2.1.4: How Does it Contribute to the Research Questions?

The synaesthetic translation tool card was inspired by the translative property or characteristic of synaesthesia (see section 5.1.1: Property 1: Translation). This property then became a card type tool so that the synaesthetic translative approaches can be shared with other people. This synaesthetic translation card answers **[RQ2]** “*What tools can be created to support these approaches / applications?*” by designing a tool that may help implement synaesthetic translation approaches in design studies. The way that this tool supports creative ideas and thoughts will be shared further in section 5.3: Workshop & Expert Feedback.

5.2.2: Synaesthetic Narrative Tool

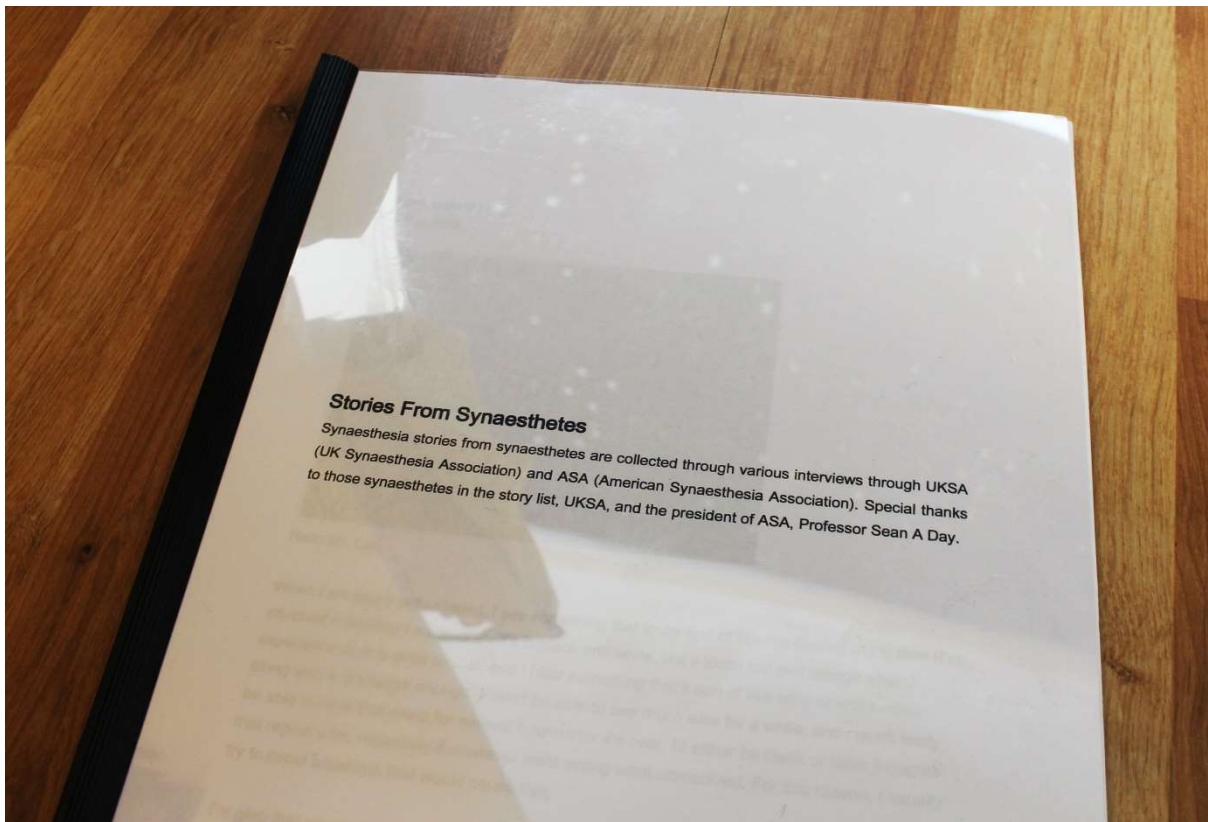


Figure.57 Stories from Synaesthetes – Narrative Tool

For most people, music can trigger emotional responses and can shift a mundane setting into an indulgent escape. Music can carry the listener out of gloomy thoughts into a safe distant space, and perhaps to a good memory. For me, a good tune not only fills my ears, but also fills my mind's eye with a visual landscape. Shapes and textures shift scale, move, and vary in monochromatic tones from the lightest whites to the darkest blacks. I like to describe what I see as a daydream which can be called upon when I choose to pay attention to it. Each sound has its own shape: round, sloppy, fluffy, awkward, large, small, sharp or jagged. A loud, low sound can be opaque, heavy, and might demand more of the foreground space in my mind. Quiet sounds can sometimes be transparent and weave in and out of the background.

I've experienced synesthesia as early as primary school when I spent summers dancing all day, trying to transform the shapes I could hear into movement. I have fond memories of a New Age album my mom brought home, the first instrumental album I heard, which brought me deeper in my exploration of synesthesia. The soundscapes of this music were very different because they did not have vocals and the shapes could be interpreted much easier.

Until this day I continue to amount a large collection of music, obsessed with visual landscapes. There are too many albums to name but Radiohead's "Kid A" is more distinctive than others. When I listen to this album, the climaxes are like visual tornadoes where shapes are indeterminable from one another and occupy the space at the same time. When these climaxes end, a few quiet sounds escape and scurry out of the scene.

I am a professional visual artist and some music albums are banned from my studio because their visual landscapes make it too difficult to concentrate. When I am installing my paintings for an exhibition, I am aware that combinations of my works can pair shapes and tones together, and that certain shapes or tones create slight vibrations in my ear and mouth. Installing can thus result in sound-surprises. I am happy re-arranging the work on the walls until I find the right vibrations. I have often wondered if others can sense this, and whether visual art can move viewers at this strange subconscious level, in ways similar to music.

Figure.58 Stories from AG

Dear Diary,

Today, after my birthday party for my eight years, I had an argument with my sister. I was saying that Saturday is red and she insisted that is yellow. Suddenly, my mother came into the room and yelled to us: Are you both crazy, young ladies? What red and yellow? Saturday is as blue as the sky is today! I don't know how to tell her to go to a doctor for her eyes...

Figure.59 Stories from DD

The synaesthetic narrative tool (fig.57) within the synaesthetic-provocation toolkit is fifteen selected stories recounting experiences of synaesthesia (see Appendix M: Stories From Synaesthetes). It was aimed as an experiment to explore how the story of synaesthesia can affect our creative insights. This tool tries to induce serendipitous inspiration through reading and accessing various synaesthetic stories.

This tool was inspired by the provocative narrative of synaesthesia and through conducting a synaesthesia experience realisation project (see sections: 5.1.2.2: Prop 2 – Project: *Angry Red*). As I have explained in section 5.1.2.1: Stories from Synaesthetes, the stories were collected through ASA, UKSA and the synaesthesia mailing list, and the interviewees granted permission to use them. The fifteen stories were selected from those that I read through the above associations over the past three years. The stories were selected based on the authors' backgrounds, which included a student, a journalist, a university lecturer, a practising artist and a poet, and the particular qualities of their respective stories. Some synaesthetes concisely explain their feelings (fig.59) and some are highly descriptive (fig.58). The narrative tool is a mixture of these inspiring stories for a variety of understandings.

There are relatively few debates within synaesthesia research regarding synaesthesia application in design (see 3.2.6: Synaesthetic Design). Thus, this tool is more of an experiment to try to discover a new way to apply synaesthesia in design. The narrative aspect was partly influenced by the literature (see section 3.1.6: Synaesthesia and Creativity) in terms of developing tangible approaches of applying intangible synaesthesia as an inspiration. The relationship between the property of narrative and the narrative tool is that the tool functions as a conveyer that delivers the quality of narrative to users. Like other synaesthetic-provocation tools, the usefulness of the tool has been improved and revealed by trying to understand the feedback from the workshop participants (see workshop sections 5.3.3 & 5.3.4 & 5.3.5).

HOW TO USE THE NARRATIVE TOOL:

1. Speculation:

This tool allows participants to read random synaesthetic stories. Each story contains different types of synaesthesia, and readers may interpret the stories however they want in order to gain beneficial inspiration. Accessing into others' experiences through articulated stories (written by synaesthetes themselves) may stimulate and encourage random thoughts. Many thinkers have argued that creative thoughts always embrace random components (De Bono 1985; Bateson, 2002), and this tool was particularly considered to share this implicit approach in design study.

2. Direct Input:

Participants can transform their chosen narrative directly into a creative practice. This means, unlike the above implicit usage (1. speculation), the participant can explicitly infuse or transform the story into their creative practice, just as I did for my early project (see section 5.1.2.2: Prop 2 – Project: Angry Red). This is an experimental approach regarding using the narrative property of synaesthesia in a design context.

5.2.2.1: Why Stories?

How can people access the experience of synaesthesia? In reality, it is impossible to experience fully the entirety of another's synaesthetic experiences. However, it is possible to understand or uncover their feeling, to some degree at least, through listening, learning and observing their experience. In itself, text is perhaps one of the most successfully and widely used formats for knowledge exchange throughout the history of mankind. Thus, I wanted participants to emphatically learn and engage with the experience of synaesthesia via text (written by synaesthetes themselves). This synaesthesia story tool may look like an unrefined, complex and less effective tool, as participants have to spend a bit of time to read the text during their idea generation. However, I thought using or

placing this rather complex reading tool together with the simple translation card kit (Card-A&B) would provide a balanced usability and impression for participants.

5.2.2.2: How Does it Contribute to the Research Questions?

The narrative or story tool was inspired by the finding of a narrative property of synaesthesia through a project (see chapter 5.1.2.2: Prop 2 – Project: Angry Red). This tool was created to share this discovered approach and property with people to challenge whether the property of narrative is potentially useful in stimulating creative thoughts and innovations. Consequently, the narrative tool directly contributes an answer to **[RQ2]** *“What tools can be created to support these approaches / applications?”*

5.2.3: Synaesthetic Mental Imagery Tool

The synaesthetic mental imagery tool was the final tool that I developed as one of tools within the synaesthetic-provocation toolkit. The tool was not available until the third workshop, because I did not come up with palpable and reasonable ideas for developing the property of synaesthetic mental imagery into some kinds of viable tools. Especially, the idea of mental imagery was even more abstract than the property of narrative, so I was rather sceptical about sharing and using this property as a creative approach via a toolkit. This was also due to my learning through one of my projects and feedback (see chapter 5.1.3: Property 3: Mental Imagery)

After the first workshop (see chapter 5.3.3: Workshop: Royal College of Art) and the second workshop (see chapter 5.3.4: Workshop: Carnegie Mellon University), I have found through my records that the narrative tool was less used and engaged with by the participants compared to the translation card tool. This knowledge somewhat pushed me to consider an additional synaesthetic provocation tool that embraces the property of mental imagery.

The synaesthetic mental imagery tool contains five different props. Each prop tries to

stimulate and convey sensory information to participants. The five tools interact with five traditionally recognized methods of perception, or sense: taste, sight, touch, smell and hearing. Although there are more than Aristotle's basic five senses in the human body (Jarrett, 2014, p.172), this choice was due to our familiarity with these particular five senses.

How To Use The Mental Imagery Tool:

Unlike the translation tool and narrative tool, these five tools are designed to be used by participants without processing any particular action (such as combining cards or reading text). The reason behind this is that I wanted to influence our thinking by shaping and accessing our sensory information in a very intuitive way, especially given that the other two tools were relatively unfamiliar and therefore more difficult to understand (such as the narrative tool). Below (fig.60 - 64) are the synaesthetic mental imagery tools that were later inspired through different workshops and by the property of synaesthetic mental imagery (see chapter 5.1.3.1: Prop 3 – Project: Drinking Electricity).



Figure.60 Mental Imagery Tool - Smell

1. Smell prop (fig.60) within the synaesthetic mental imagery tool contains different essential oils that allow participants to experience different smells. They can be sniffed as participants wish, and stimulate their sensory information in order to facilitate their creative dimensions.

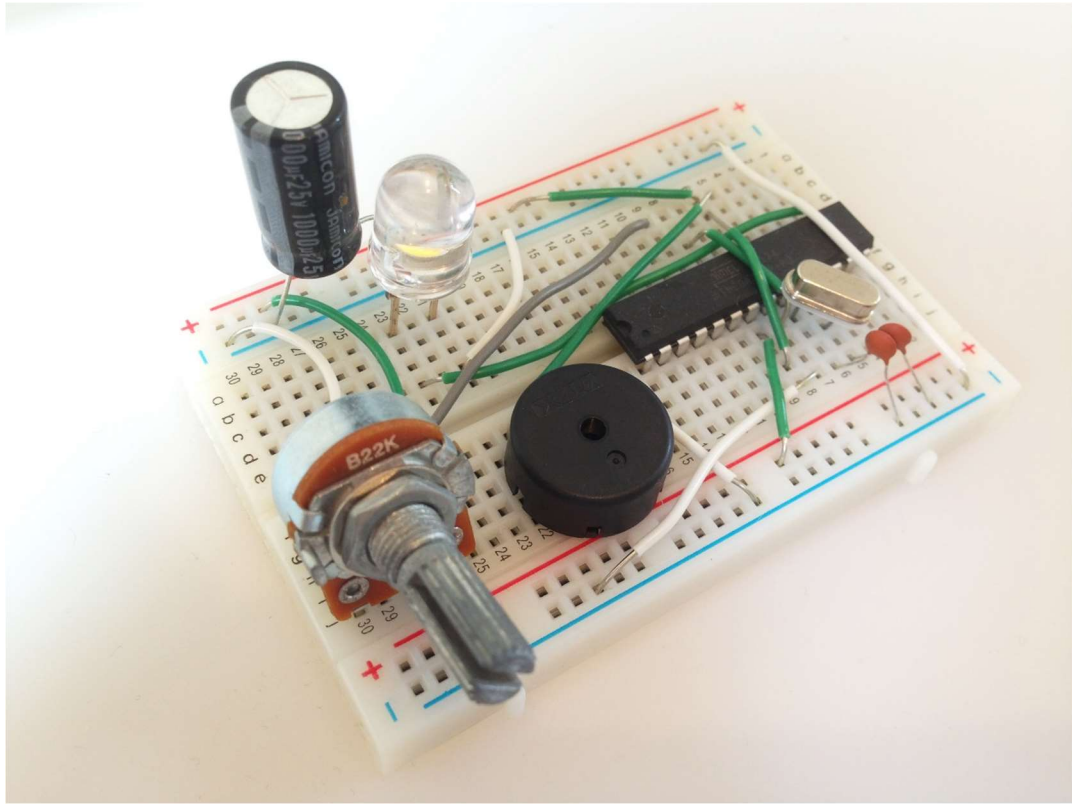


Figure.61 Mental Imagery Tool - Sound

2. The sound prop (fig.61) is an operable mini electronic device that creates sound and light according to the rotation of the potentiometer. Participants can use this tool to play and think through the auditory experience it provides. The sound is also mapped with a LED that changes depending on the sound pitch it emits (darker for lower-pitched sounds and brighter for higher-pitched sounds)²⁷.

²⁷. Demonstration: <https://www.youtube.com/watch?v=b9UbWZSlcJE>



Figure.62 Mental Imagery Tool - Vision

3. The vision prop (fig.62) is a mirror tool that attempts to share the idea of vision. The reason I chose to use a mirror as a vision tool was that a mirror constantly reflects light and changes its display and interface. This handy little screen can offer unlimited visual information, depending on the interactions of the participants.

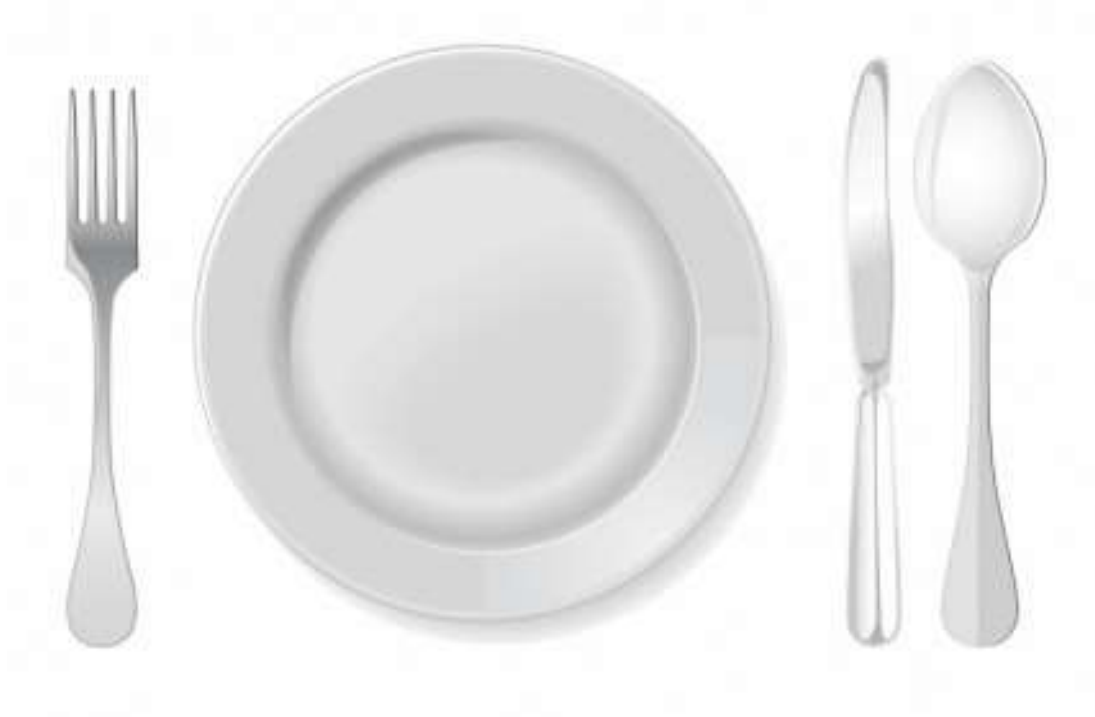


Figure.63 Mental Imagery Tool - Taste

4. The taste tool (fig.63) contains a small empty plate with a fork, a knife and a spoon. Anything can be placed on the plate, from non-edible products to edible foods. However, participants cannot eat or consume them; they can only 'taste' them with their mind. The previous project directly influenced this imagination-evoking tool. (see chapter 5.1.3.1: Prop 3 – Project: Drinking Electricity).

This tool did not give a decent impression to testbed participants and was later removed from the synaesthetic mental imagery toolkits (see chapter 5.3.5: Workshop: Officer RH). The idea of stimulating taste was then substituted by the idea of smell, as the perception of flavour comes from the combination of odour and taste information of the chemosensory regions of the brain (Small and Prescott, 2005, p.345).

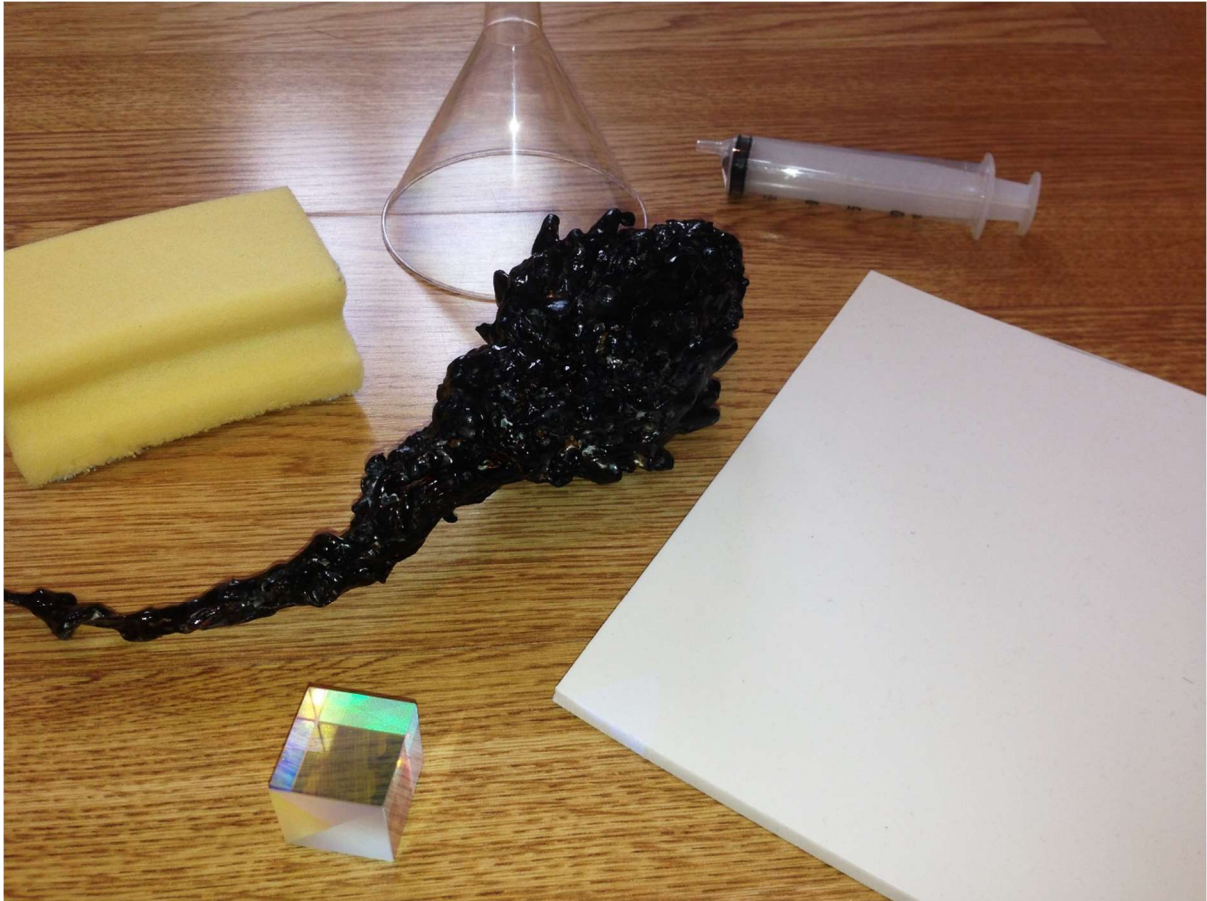


Figure.64 Mental Imagery Tool - Touch

5. Touch tool (fig.64) is a collection of materials that helps to induce participants' tactioception²⁸. The items are composed of different textured materials: sponge, square reflective glass, syringe and silicone. I also used a shaped structure as well as an art work that I bought from an artist, Dr. Timothy Layden (synaesthete), who I interviewed in person for research feedback (see chapter 5.3.6: Expert Feedback: Dr. Timothy Layden). The participants can feel free to play and experience the textures by interacting with the provided materials, which help to provoke their senses for potential inspirations.

²⁸. "Tactioception refers to the body's ability to feel physical sensations such as smooth, rough, hot, cold, pleasant, painful, etc. This sense uses several modalities; pressure, skin stretch, vibration and temperature to transmit messages to the brain via the sensory neurons." (AlleyDog, n.d.)

5.2.3.1: Why Sensory Prop?

How can the property of synaesthetic mental imagery be delivered to others and influence their creative thoughts? The concept of mental imagery is enormous, and this presented initial problems in terms of creating the quality of synaesthetic mental imagery into deployable tools. By adapting Sherry Turkle's (2011) quote, "We think with the objects we love; we love the objects we think with", I was encouraged to think of the possibility of using props to access our senses. Turkle, a sociologist, does not consider objects as mundane everyday props, but as companions to our emotional lives, capable of evoking and spurring our thoughts. This concept partly inspired the idea of the sensory prop, and this idea directed me to consider sensory experiential or sensory accessing props as a tool of applying the quality of synaesthetic mental imagery for ideas generation.

5.2.3.2: How Does it Contribute to the Research Questions?

The synaesthetic mental imagery tool was inspired by the discovered property of synaesthesia through a project and was established after the second workshop (see sections 5.2.3 & 5.3.4). This tool became a tool within the synaesthetic provocation toolkits to support approaches of synaesthesia application in generating creative ideas. Therefore, this tool has contributed in answering **[RQ2]** "*What tools can be created to support these approaches / applications?*" in terms of refining the toolkit. As I have mentioned in the above chapter, the application of these tools will be addressed in chapter 5.3: Workshop & Expert Feedback.

5.3: Workshop & Expert Feedback

By discovering three properties and approaches of applying the idea of synaesthesia through the project *Three Studies of Synaesthesia*, this research has conceived to create a synaesthetic-provocation toolkit that may support synaesthesia applications. This chapter will present how the synaesthetic-provocation toolkit supports three

approaches to applying the idea of synaesthesia in generating creative thoughts, debates and innovations. This chapter will try to share the usefulness of the toolkits through four workshops in order to validate my approaches of synaesthesia applications. This chapter also covers experts' feedback regarding my PhD research and finding.

5.3.1: Workshop Audience & Why Workshop?

This workshop covers a variety of audiences from design experts to a potential British paratrooper and myself. The intention behind the varied audience selection was to ascertain whether the toolkits would be useful for different types of audiences when used in different contexts. The first workshop was held at the Royal College of Art, London, where I am conducting my PhD studies. The second workshop was held at Carnegie Mellon University, Pittsburgh. The third workshop was with a British officer cadet. I conducted the fourth workshop by myself to experience my own toolkit, details of which are listed separately in the Appendix L: Workshop with Myself.

The synaesthetic-provocation toolkit was mainly created to facilitate ideas generation for creative practitioners. However, people from non-design backgrounds who want to generate debates and ideas can also use it. The four workshops included participants from design backgrounds and non-design backgrounds. The conducted workshops did not include or invite synaesthetes as workshop participants due to their prior knowledge regarding synaesthesia. I thought their synaesthetic experience and understanding could cause difficulty in distinguishing the usefulness of toolkit in evidential terms.

As I have mentioned in chapter 4.7: Workshop & Toolkit, workshops and toolkits are useful to understand participants' thought processes by listening, observing, uncovering, communicating and valuing their feelings and imaginations. A workshop is a space that enables participants and the facilitator to play and explore uncertainty and subjective experience. This participatory approach is a helpful method to understand participants' feelings regarding the toolkit, which is a necessary aspect of this PhD study. Workshops are not just useful in the field of design, but are used in various disciplines including the

game industry, business, elementary education, ergonomics, architecture planning and so on. Workshops cultivate a variety of information from people that helps the facilitator to learn tacit knowledge and insights that are usually difficult for an individual (or stakeholder) to learn (Frascara, 2002; Polanyi, 1983; Gaver, Dunne and Pacenti, 1999; Fullerton, 2014).

5.3.2: Themes / Tasks

To validate my approaches of synaesthesia application and toolkits through workshops, I had to create a space where I can test these approaches, that is, to explore their usefulness in creative idea generation for design. For this reason, I created seven different intriguing themes or tasks that allow participants to engage creatively with the synaesthetic-provocation toolkit. These various themes were initially created based on my interest and curiosity in exploring different knowledge as a designer. I was also to find out whether the synaesthetic-provocation approaches could be used to stimulate ideas around different avenues. Imagining these various creative themes in relation to synaesthetic-provocation approaches made the research environment more creatively flexible and helped me to resolve some of my discomfort during this PhD study (see chapter 4.3: Anxiety).

Some of the initial themes were deleted and some new themes were added based on participants' knowledge and demands. By receiving and adapting a number of rounds of feedback throughout the workshops using these themes, the synaesthetic-provocation toolkit has evolved and become more accessible for idea generation processes.

Below are the seven themes that I created for the workshops and the reason for the formation of the themes.

THEMES / TASKS:

Theme 1: You are going to a friend's upcoming birthday gathering. Design any gift or present that may surprise your friend. (You are free to choose any medium you want, so it could be something like a product, art, graphic, souvenir, toy, furniture, technology, performance, instrument, apps etc.)

Behind the theme:

The theme was shaped in 2016 as Christmas approached. The concept of Christmas presents partly motivated me to come up with this theme. In addition, the theme was also inspired by my excitement regarding playful components that surprise people. This theme later merged with theme 2, as some participants thought the two themes were relatively similar to one another.

Theme 2: Create a playful thing for yourself. You are free to create anything you want, so it could be something like a product, art, graphic, souvenir, firework, furniture, technology, performance, instrument etc.

Behind the theme:

This theme was merged with theme 1 after the first workshop due to its similar context. The idea of playful things was from my deep interest in toy innovation and entrepreneurship while conducting this PhD. I wanted to know how other people could create intriguing toy concepts through synaesthetic-provocation.

Theme 3: You are a military weapons designer. Design any military weapon and scenario that helps a nation's military defence (NOT offence).

Behind the theme:

This theme was designed particularly for officer cadet RH (see section 5.3.5: Workshop: Officer Cadet RH), who had a substantial interest in innovation, design and electronic engineering. I wanted to experiment and know how a non-design and engineering professional (RH is an expert in counter-terrorism) can handle such a task through the synaesthetic-provocation toolkit. I was interested in looking for potential ideas and thoughtful innovation. This theme was produced through theme 7.

Theme 4: Robot X cannot perform any function and cannot recognise anything. Provide any abilities to Robot X and create your own robot. Think about possible scenarios of how people could interact with this robot. You are free to create any kind of robot, so it could be something like a vacuum cleaning bot, scary bot, musician bot, security bot, dumb bot etc.

Behind the theme:

The idea of robot X was inspired by the French philosopher Étienne Bonnot de Condillac's idea of a statue. In his *Traité des sensations* (1754), where he stated the content of the human mind as an accumulation of sensation and mental impressions, he used a statue as an analogy. He imagined a statue that has the quality of man's organic structure, and then awakened their senses, one at a time, beginning with smell. The statue then experiences his surroundings through unlocked senses and distinguishes his own surrounding based on awakened senses²⁹. This analogy of the statue gave me an impression of a godlike being awakening a human, which inspired me to conceive the relationship between robots and humans.

²⁹. More info: <https://plato.stanford.edu/entries/condillac/#Treatise>

Theme 5: Design a SPECIAL musical instrument that is different. You are free to create or invent any type of instrument.

Behind the theme:

There has been a relationship between music and synaesthesia for over one hundred years (Brougher, et al., 2005). This historical understanding naturally led me to create and view how such a theme can be processed through synaesthetic-provocation. I particularly emphasised the idea of "SPECIAL" instrument in order to induce more unusual, novel ideas from the participants.

Theme 6: Create a possible renewable energy, recycling scenario or a product that helps to recycle something into energy.

Behind the theme:

The theme was developed as I tacitly thought there must be some kinds of relationship between the translative property of synaesthesia and the renewable, recycling scenario of energy.

Theme 7: Create your own themes that relate to your concerns and generate ideas based on the theme.

Behind the theme:

The purpose of this theme was to embrace any concerns that participants may have. As I have mentioned above, theme 3 was generated through theme 7. The idea of theme 7 was to investigate whether the synaesthetic-provocation approaches can be used to encourage ideas around various concerns and issues.

5.3.2.1: How Does it Contribute to the Research Questions?

The themes provide space and opportunities to examine and validate synaesthetic-provocation approaches and toolkit through workshops. By applying these creative themes to workshops and discovering the participants' experiences, this research can learn how the synaesthetic-provocation approaches and toolkit is useful in stimulating creative dimensions. This means the themes directly try to contribute an answer to **[RQ1]** *“How can the characteristics / properties of synaesthesia be used / applied to stimulate creative idea generation and debate?”* The themes can be also recognized as a tool that examines the synaesthetic-provocation toolkit. Therefore, the themes correspondingly contribute to **[RQ2]** *“What tools can be created to support these approaches / applications?”*

The themes work as a facilitating agent that connects synaesthetic-provocation approaches, toolkit and workshop participants.

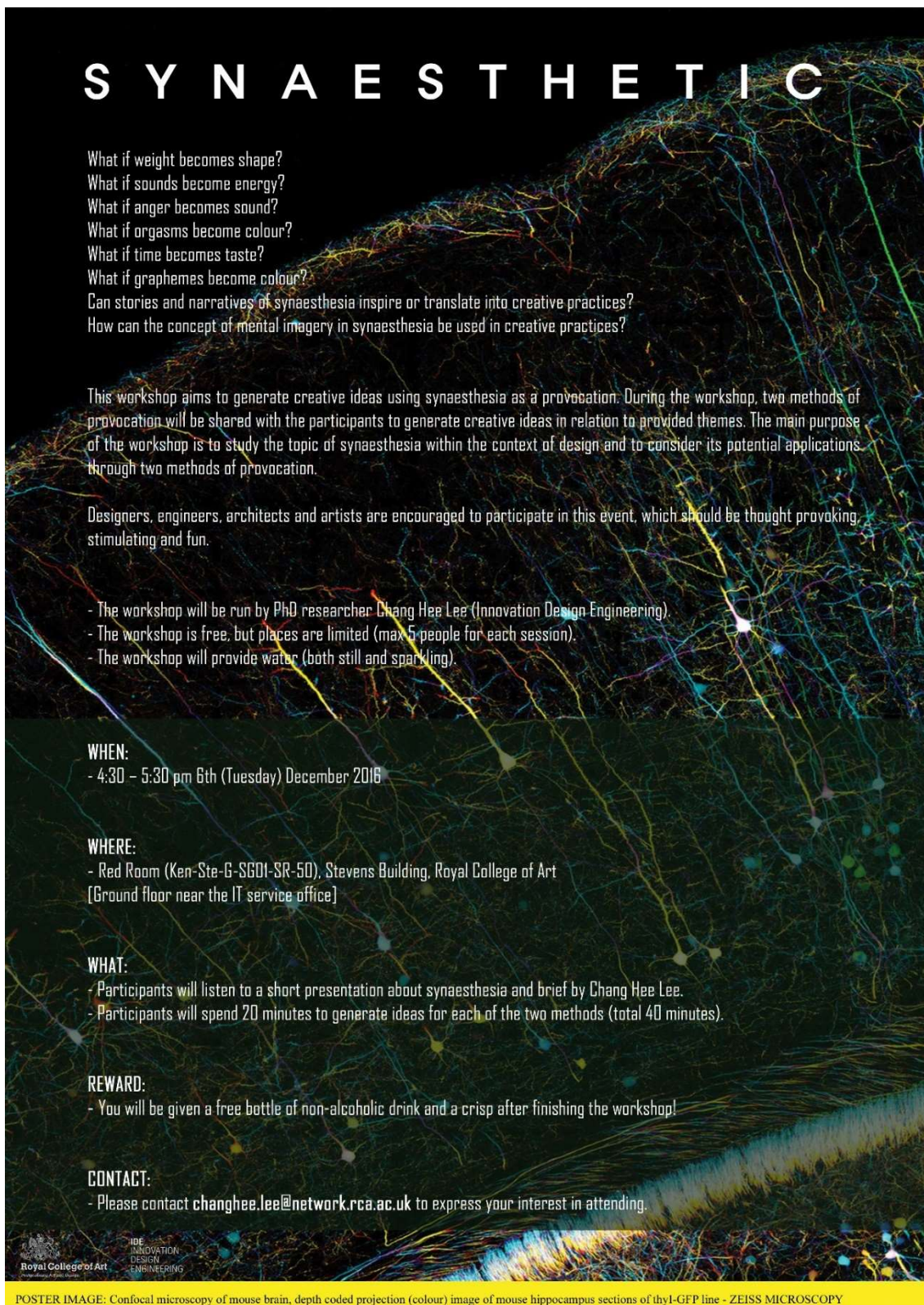
5.3.3: Workshop: Royal College of Art



Figure.65 First Workshop at the Royal College of Art

London's Royal College of Art (RCA) is the only entirely postgraduate art and design university in the world. The institution comprises six schools: schools of Design, Fine Art, Architecture, Communication, Humanities and Material (Gander, 2016). The first workshop was held here at the RCA as I wanted to familiarise the process of organising workshops to learn how to communicate with workshop participants. Holding the workshop at the RCA also enabled me to see how design professionals could use the synaesthetic-provocation approaches and toolkit. The reason I am classifying students at the RCA as design professionals is that many students coming to study design at the RCA have at least an undergraduate degree in one of the fields of design, fine art, engineering, architecture or social science, and they have some experience in professional design or art practice. As such, I am comparing these individuals with people who lack any knowledge in relevant design disciplines and professional practice, so the designation of the RCA students as design professionals or specialists is relative. The reason for choosing to categorise at all was that I wanted this research to validate the toolkit through both

design and non-design professionals. In this regard, the workshop held at the RCA was one of the validations through design professionals.



SYNAESTHETIC

What if weight becomes shape?
What if sounds become energy?
What if anger becomes sound?
What if orgasms become colour?
What if time becomes taste?
What if graphemes become colour?
Can stories and narratives of synaesthesia inspire or translate into creative practices?
How can the concept of mental imagery in synaesthesia be used in creative practices?

This workshop aims to generate creative ideas using synaesthesia as a provocation. During the workshop, two methods of provocation will be shared with the participants to generate creative ideas in relation to provided themes. The main purpose of the workshop is to study the topic of synaesthesia within the context of design and to consider its potential applications through two methods of provocation.

Designers, engineers, architects and artists are encouraged to participate in this event, which should be thought provoking, stimulating and fun.

- The workshop will be run by PhD researcher Chang Hee Lee (Innovation Design Engineering)
- The workshop is free, but places are limited (max 5 people for each session).
- The workshop will provide water (both still and sparkling).

WHEN:
- 4:30 - 5:30 pm 6th (Tuesday) December 2016

WHERE:
- Red Room (Ken-Ste-6-SG01-SR-50), Stevens Building, Royal College of Art
[Ground floor near the IT service office]

WHAT:
- Participants will listen to a short presentation about synaesthesia and brief by Chang Hee Lee.
- Participants will spend 20 minutes to generate ideas for each of the two methods (total 40 minutes).

REWARD:
- You will be given a free bottle of non-alcoholic drink and a crisp after finishing the workshop!

CONTACT:
- Please contact changhee.lee@network.rca.ac.uk to express your interest in attending.

Royal College of Art
INNOVATION
DESIGN
ENGINEERING

POSTER IMAGE: Confocal microscopy of mouse brain, depth coded projection (colour) image of mouse hippocampus sections of thyl-GFP line - ZEISS MICROSCOPY

Figure.66 Workshop Poster

For the first workshop, I created a poster (fig.66) to call for participants who had an interest in the subject. Posters were distributed in both physical form and online, via emails to different schools within the RCA. In total, eight people contacted me over a month, but only three people showed up for this workshop. Nonetheless, the number of participants was ideal for me as I initially planned to have a maximum of five people for the workshop. I wanted a smaller workshop due to my previous negative experience of being one of the participants within crowded workshops (crowded here means between twenty and forty people).

Throughout my experience as a workshop participant in the past, I have noticed that it is rather difficult to mediate, command and listen to each participant when there are a large group of people. Whenever I participate in workshops with crowds, I often experience myself as a useless or valueless thing or component, as nobody seems to listen carefully to my ideas or thoughts in great detail. This rather unpleasant experience made me consider this type of environment as a negative and discouraging space, one in which participants are less likely to contribute. Further, while it is true that some workshops may need many participants for various objectives, the main purpose of my workshop was to explore and find out how the synaesthetic-provocation toolkit and approaches influenced individuals' creative dimensions in generating different innovations. A smaller group of participants made it more comfortable to access and listen to their personal experience. Apart from my personal experience, the choice was also influenced by participatory design expert Elizabeth Sanders's (Sanders, Brandt and Binder, 2010) view on group size and composition. She states that understanding the applications of tools and techniques is best done individually rather than collectively as it can capture unique individual experiences.

Although the workshop at the RCA only had designers as participants, I have partly adopted Sanders' (Sanders and Stappers, 2008; 2012; Frascara, 2002; Sanders, Brandt and Binder, 2010) participatory design framework to learn the basics of how to organize tools and techniques for better learning through workshops. This framework aids access to the participants' experiences more closely, so a better research outcome can be achieved. I have also looked into IDEO's Design Thinking for Educators toolkit (IDEO, 2013)

mindset as a beneficial reference for organizing other workshops.

I have used part of Sanders's (2002) technique of accessing participants experience by

- listening to what people say.
- interpreting what people express, and make inferences about what they think.
- watching what people do.
- observing what people use.
- uncovering what people know.
- reaching toward understanding what people feel.
- appreciating what people dream.

By discovering how people think and know, we may learn their perceptions of experience. Appreciating how they feel allows us to access their concerns, and this way of knowing provides tacit knowledge (Polanyi, 1983). This workshop approach towards participants' tacit knowledge and experience was to see the creative possibilities of the toolkit and approaches. Apart from the above research, the process of workshops directly associates to both **[RQ1]** *"How can the characteristics / properties of synaesthesia be used / applied to stimulate creative idea generation and debate?"* and **[RQ2]** *"What tools can be created to support these approaches / applications?"* Below are the procedure, basic layout and list of participants of the first workshop.

WORKSHOP PROCEDURE:

1. INTRO:

Introduction of synaesthesia and the research focus with my projects at the beginning of the workshop (icebreaker).

Duration: [10 - 15 minutes]

2. IDEA GENERATION:

Participants begin to generate ideas using the synaesthetic-provocation toolkit based on their themes.

Duration: [45 - 50 minutes]

3. DISCUSSION:

Each participant presents their concepts, and discusses and shares feedback on how the synaesthetic-provocation toolkit (at this stage the mental imagery tool was not part of the toolkit) has affected their creative dimension and idea generation process.

Duration: [1 hour or more]

4. REWARDS: RELAXING DISCUSSION:

Drinking a can of non-alcoholic drink with crisps so participants can relax after the workshop, which can encourage informal conversation

5. REALISATION:

After the workshop, participants are free to co-create and realise their project ideas into

tangible objects if they desire.

USED MATERIALS:

- Tool: card-A
- Tool: narratives
- Basic writing utensils (e.g. A2 papers, pens, markers)
- Introduction sheet
- Rewards after finishing the workshop: non alcoholic drinks & crisps

RULES:

- You can use any card you want to encourage your ideas. (see chapter 5.2.1.2: Card-A)
- You can also use an individual card as a provocation for ideas generation.
- You can use any narrative / stories you want as a provocation. (see chapter 5.2.2: Synaesthetic Narrative Tool)
- Write and record which of the cards or narratives you have used for provocations next to your ideas.
- Create 1 or more ideas
- You may sketch or write on the provided paper.
- Be brave and playful. Your ideas do not have to be perfect!
- Briefly present about the ideas you have created!

WORKSHOP LAYOUT:



DESK TOP VIEW

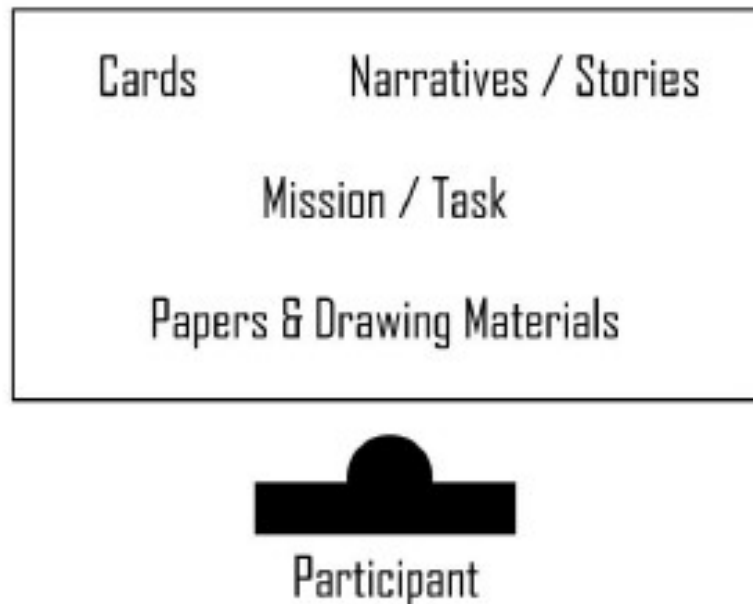


Figure.67 Workshop Layout

INFO OF PARTICIPANTS:

Participant 1: DC

DC was one of the participants who had a deep interest in collective data, creativity and games. He once designed a toolkit that enables elderly people to engage in discussion about depression and mental illness within senior centres. This means he has experience in running different workshops in his previous design study. One of his latest projects includes an open sandbox game that allows people to fidget and wander around in a virtual world to facilitate their creative minds and ideas together with other people. He has an undergraduate degree in Mechanical Engineering and was a master's student in the Global Innovation Design programme at the Royal College of Art and Imperial College London at the time of this workshop.

Participant 2: EG

EG was a Masters of Research student in the School of Communication at the Royal College of Art. She has an undergraduate degree in Fine Art and an interest in subjects such as empathy, telepathy and neuroscience. Her interest in neuroscience brought her to the workshop.

Participant 3: MS

MS was a first year PhD student in Innovation Design Engineering at the Royal College of Art. He worked as a researcher in the Human-Computer Interaction (HCI) team at Fraunhofer and has had an internship at Microsoft. He has an undergraduate degree in Anthropology and a master's degree in Multimedia. His PhD research focuses on symbiotic relationships in digital environments regarding biological interactions within the context of design.

ADAPTED THEMES:

All the participants have created ideas in relation to both themes below.

Theme 1: Surprising Birthday Gift - *You are going to a friend's upcoming birthday gathering. Design any gift or present that may surprise your friend. (You are free to choose any medium you want, so it could be something like a product, art, graphic, souvenir, toy, furniture, technology, performance, instrument, apps etc.)*

Theme 2: Playful Things - *Create a playful thing for yourself. You are free to create anything you want, so it could be something like a product, art, graphic, souvenir, firework, furniture, technology, performance, instrument etc.*

5.3.3.1: Ideas Discussion

PARTICIPANT 1: DC

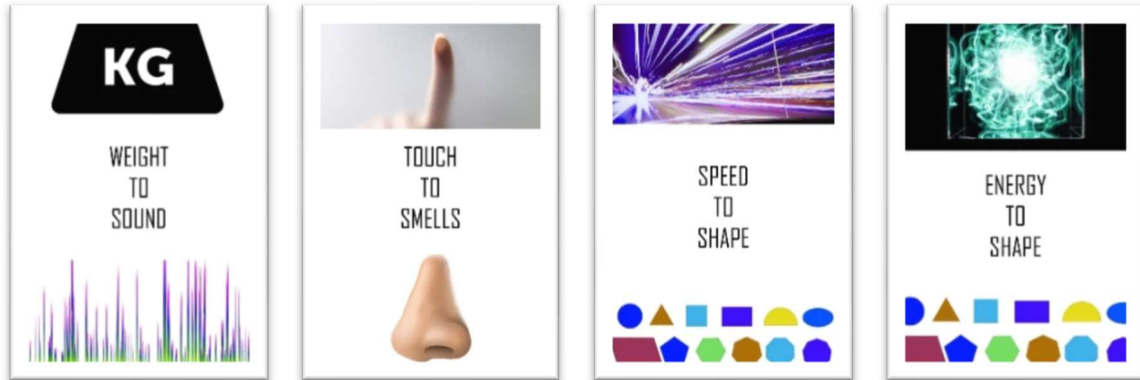


Figure.68 DC's Synaesthetic Translation Cards (card-A) Usage

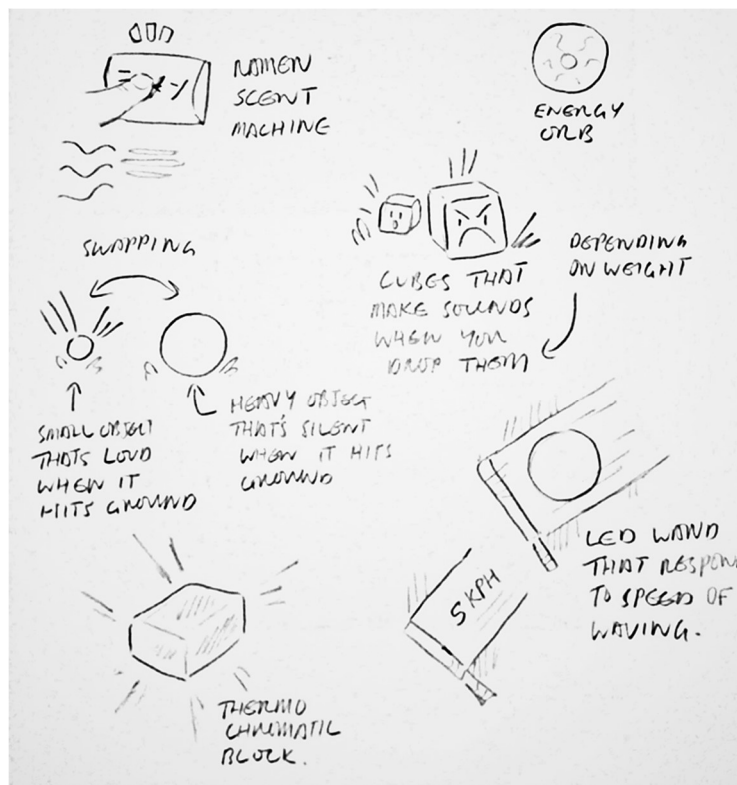


Figure.69 DC's Sketch – 1

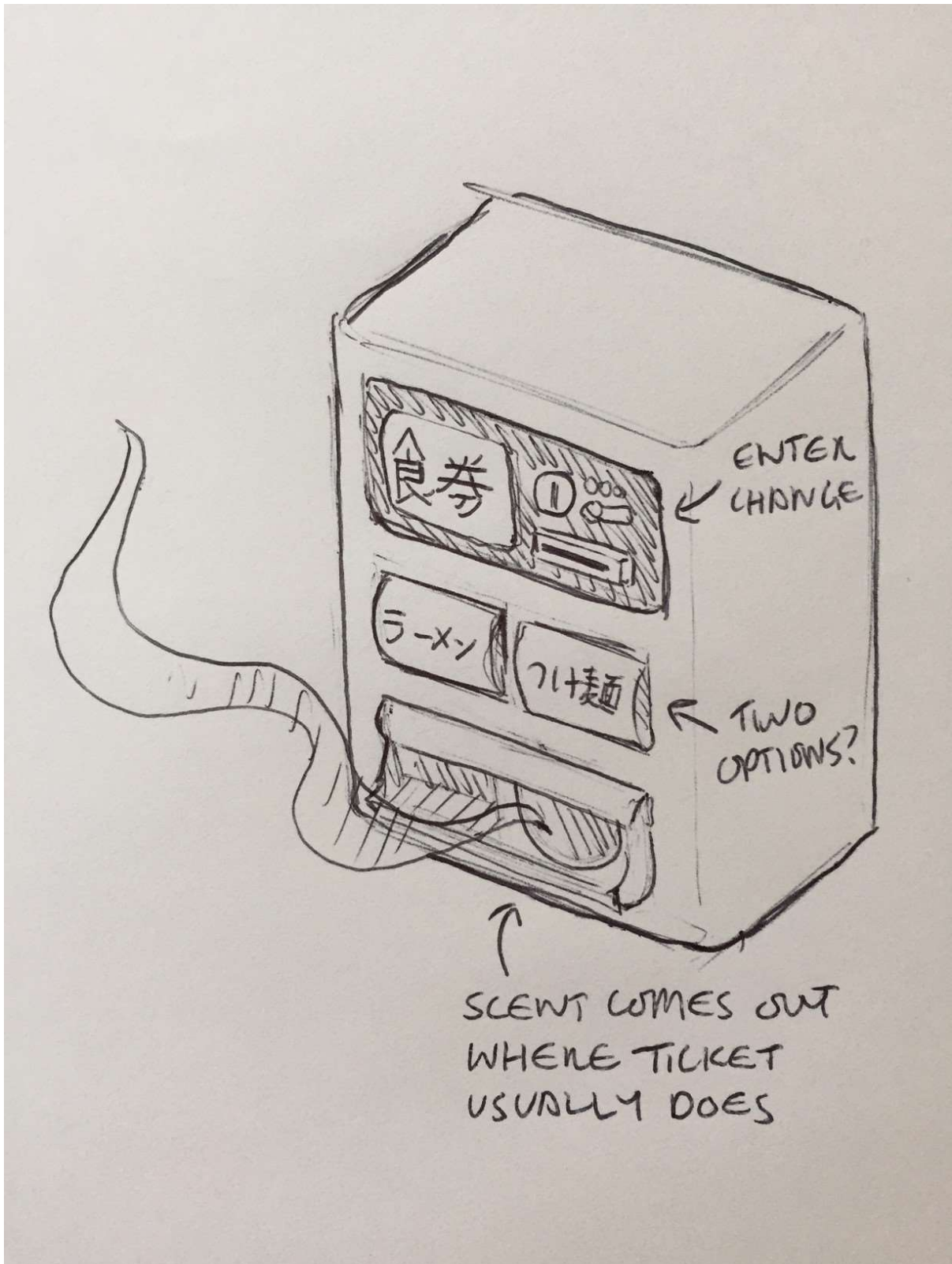


Figure.70 DC's Sketch 2 – Ramen Machine

DC used four different translation cards (card-A) (fig.68) and created three probable ideas within the five ideas in relation to the theme 1 (Surprising Birthday Gift) and used three narratives to generate ideas for theme 2 (Playful Things). Below are the written ideas based on a voice recording and my communication experience with DC. All the participants permitted the use of the information (data) that was collected in the workshop.

Creation – 1 for Theme 1 (weight-sound card):

DC proposed using the weight-sound card (fig.68) to design a surprising birthday gift, which was a small, lightly weighted ping-pong-looking ball (fig.69) that creates a loud sound, like a heavy object, when it is dropped. Another ball works the opposite way: a heavily weighted ball-object that creates almost no sound when it is dropped.

DC was quite excited about the idea as I certainly showed my interest with a like-minded discussion about fun scenarios regarding this creation. The unexpected quality, or result of the interaction with DC about the ball, motivated me in many ways, and reminded me of the definition of a novelty item: “A new item; something which has never been encountered before (with the implication that it will quickly disappear); specifically a frivolous thing, which has a certain amusement value, but usually little else to recommend it.” (Oxford University Press, 2017).

After the workshop, I wanted to realise this project into a real thing in collaboration with DC, but, after further discussion, we opted to pick his idea of the ramen machine for realisation instead of the ping-pong ball (see below creation 3).

Creation – 2 for Theme 1 (speed-shape card):

DC proposed a flag or LED wand (fig.69) using a speed-shape card (fig.68) that responds to the speed that it is waved. The quicker you wave the wand, the brighter it becomes. It was a surprising gift, which he designed to celebrate a friend’s birthday gathering.

In my observations, I felt that DC did not seem to care for or enjoy this idea. My perception was due to his short and quick explanation about this creation. His reaction made me concerned that participants usually have a few ideas that they particularly appreciate, but that they quickly discard the others. Creation 4 was also one of those creations.

Creation – 3 for Theme 1 (touch-smell card):

Using the touch-smell card (fig.68), DC came up with the concept of a machine that creates a smell of ramen. The smell of ramen is produced when someone inserts a coin and presses a dispense button. The concept of the machine's design was inspired by DC's consideration of his close friend's upcoming birthday gathering, which was within the coming week. DC wanted to create a special gift for his friend, who loved to eat pork noodle ramen when travelling across Japan. By designing this unusual machine, DC wanted to trigger his friend's joyful memories of travelling in Japan through the smell of pork ramen.

I was tremendously excited about this idea, as the ramen smell-dispensing machine sounded exceptionally fun to me. I later discussed this idea with DC and developed it in more detail in the hope of realising this idea into a tangible object. This plan of idea realisation was to see how this unusual machine communicates with other people. The process of idea generation, starting with using card-A, then working with theme 1, through to the idea realisation stage, where the idea could be shared with the public, made me keen to experience other people's reactions of how they engage with this bizarre, smelly ramen machine.



Figure.71 DC's Ramen Machine Realisation 1



Figure.72 DC's Ramen Machine Realisation 2

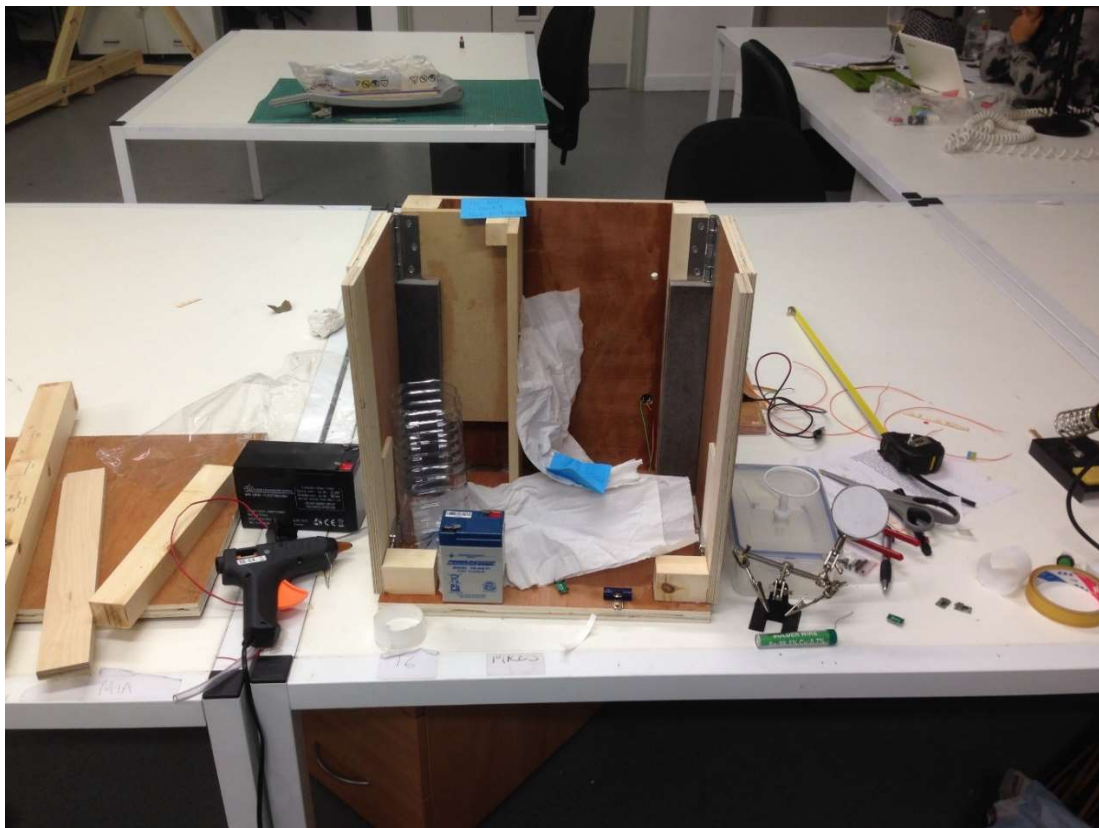


Figure.73 DC's Ramen Machine Realisation 3

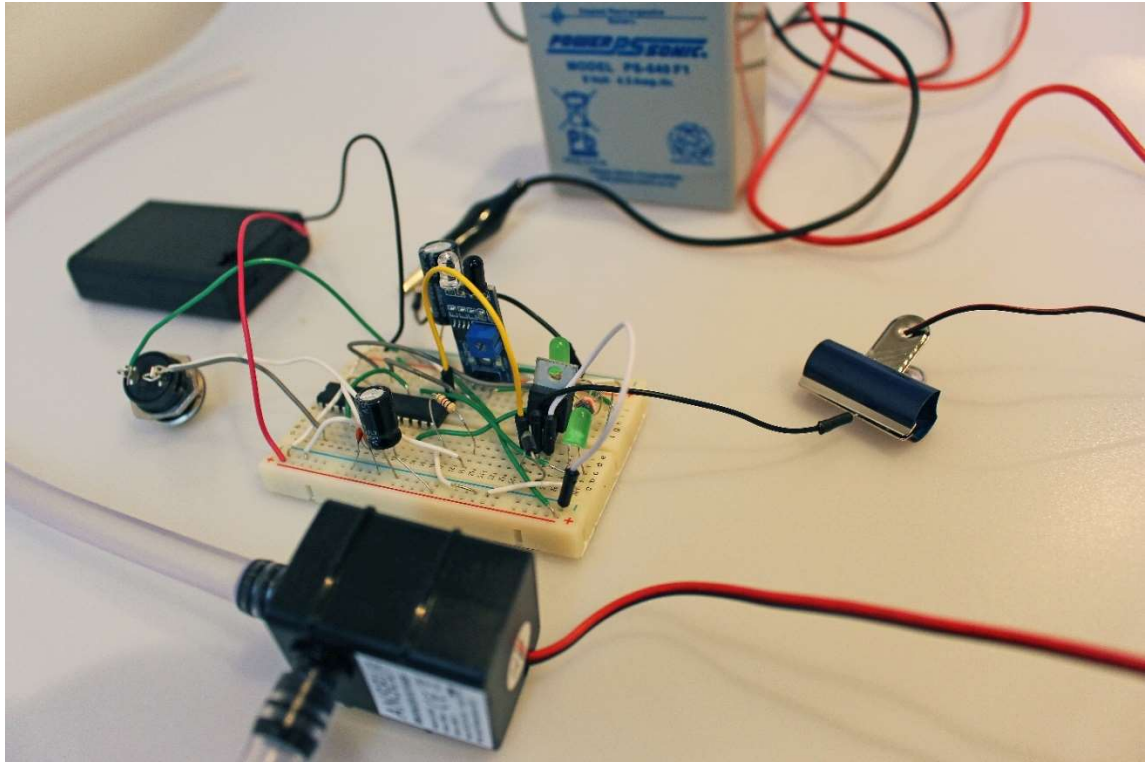


Figure.74 DC's Ramen Machine Realisation 4

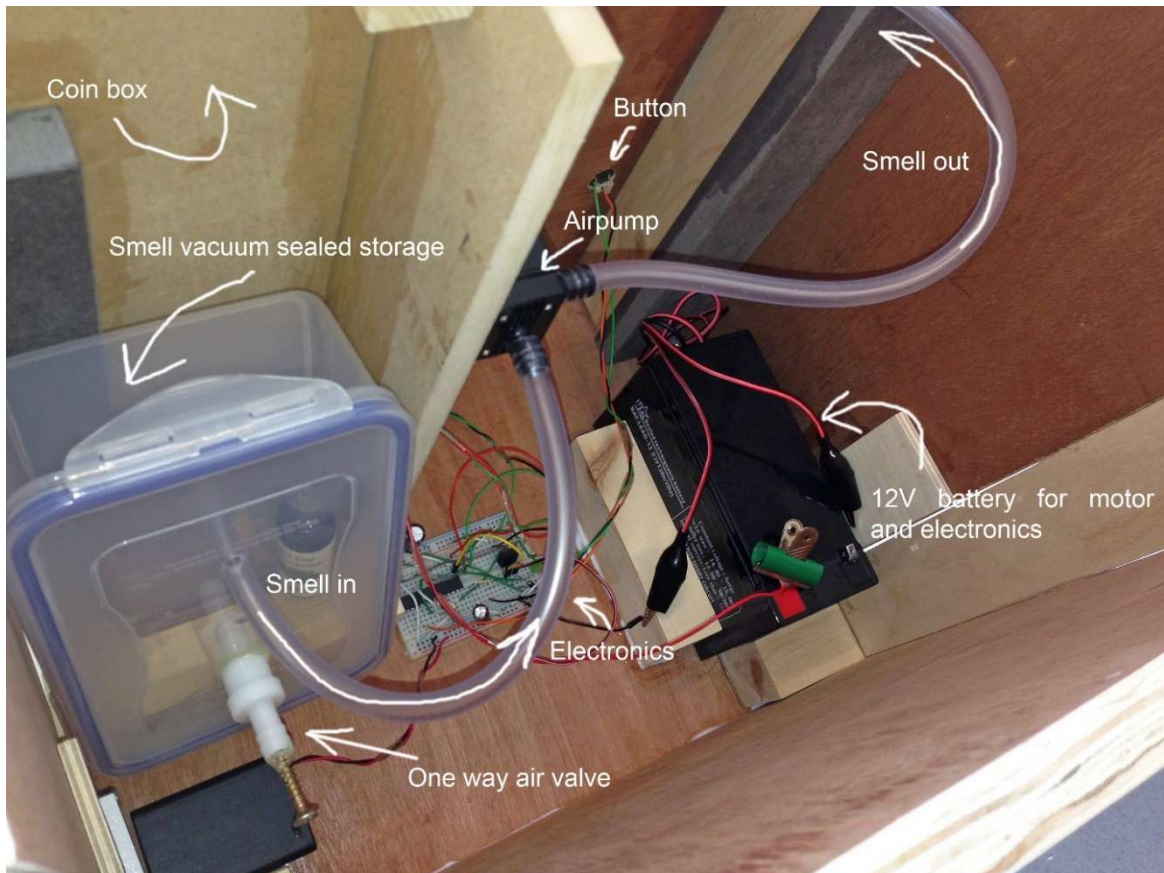


Figure.75 DC's Ramen Machine Realisation 5



Figure.76 DC's Ramen Machine Realisation 6



Figure.77 DC's Ramen Machine Realisation 7

Figures 71 to 77 are images of the realisation of the smelly ramen machine. I requested DC to create an approximate shape of the machine and a clear concept with a simple concept drawing after the workshop (fig.70). I built the electronic circuits (fig.74 & 75) before building the external structure. The structure was made of re-polished wood and supporting metal legs that I found in a large waste disposal container at the Royal College of Art. This usage of reusable trash was because the key focus of the realisation was not

about creating a complete product-like machine, but simply to test out its idea, function and interactive quality.

This machine functions in a fairly simple way. It accepts any type of inserted coin, and then a green LED light comes on to indicate it is working (fig.77). After this, users can press the green button to dispense the smell through a tiny hole (fig.76 & 77). This smell is then released through an air pump for 15 seconds from a chamber (fig.75)³⁰.

I have invited many of my PhD colleagues to visit the PhD studio and interact with the machine by organising a PhD researchers' wine and cheese gathering. This realised idea gave me an opportunity to access people's experience on this smelly ramen machine. Overall, people enjoyed playing with the machine, as it was an interactive apparatus and gave them a direct sensory experience. Similarly, the audiences at Harvard University³¹ and Carnegie Mellon University also enjoyed this machine. This response partly suggests that the provocative properties and approaches of synaesthesia through my toolkit may facilitate idea generation capable of making people experience something good.

Below are some of the informally recorded comments, chats and experiences regarding the smelly ramen machine.

1. "This smelly ramen machine is appealing. It is fun and playful. Actually, I was more interested in the sound it creates (sound of air pump motor). I research motion and it reminds me of some sorts of motion or funny facial impression. The feeling is hard to express."
2. "Sniffing through a tiny hole makes me to concentrate more to the smell. I like how it looks. It looks like a senseless machine, but provides sensory experience"
3. "How does this machine link to synaesthesia research?" (This question gave me an opportunity to deconstruct my research in a way, almost like a process of reverse engineering.)

³⁰. Smelly Ramen Machine demonstration: <https://youtu.be/DKvj6FELihQ>

³¹. Harvard University ASA National Conference enjoying the machine (see between 13:35 - 14:50): https://youtu.be/LErIgs58_M4

Overall, most people thought the machine was engaging in general due to its joyful and unexpected quality of interaction.

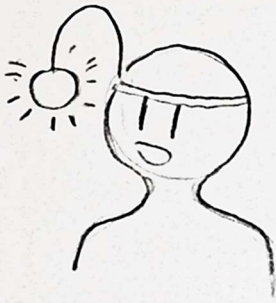
Creation – 4 for Theme 1 (energy–shape card):

A thermochromic block-like object that changes colour when it is touched by a hand (fig.69). This idea was described in a single sentence.

Creation – 5 for Theme 1 (energy–shape card):

A thermochromic dumbbell that changes shape based on the degree of strength exerted by the user; the more use exerted, the more the dumbbell changes shape. This dumbbell accumulates the strength it receives and eventually transforms its shape. In this creation, the concept of energy is covered by the context of strength.

STORY 10



ANGER SUPPRESSION

- PUT A SHINING WHITE LIGHT WHICH JULIA SEES A DARK CLOUD.
- CAN IT COUNTER HER FEELINGS OF ANGER?

STORY 13



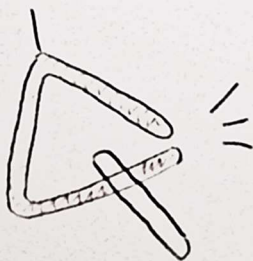
VISUALISING PAIN FOR KIDS

- CREATING THEIR IMAGE AT A YOUNG AGE.
- HOW CAN THIS HELP THEM BE MORE EMPATHIC.



A PART OF THEIR BAND KIDS?

STORY 2



SYNÆSTHESIA TRIANGLE

- SIMPLEST INSTRUMENT
- COLOUR CHANGES DEPENDING ON HOW HARD YOU HIT IT.

Figure.78 DC's Sketch - 3

STORY 3



FRUSTRATION SHARER.

- HEADPHONES THAT PLAY WHITE NOISE ON LOUD SOUND WHEN YOU ARGUE - PARTNER GET FRUSTRATED
- FEEL THEIR FRUSTRATION

STORY 4



LIGHT CALENDAR

- LIGHT COLOUR CHANGES ON DAYS OF THE WEEK
- THEY SHINE LIKE AN ALARM
- SET THE MOOD IN YOUR ROOM.

Figure.79 DC's Sketch - 4

Creation – 6 for Theme 2 (story 10):

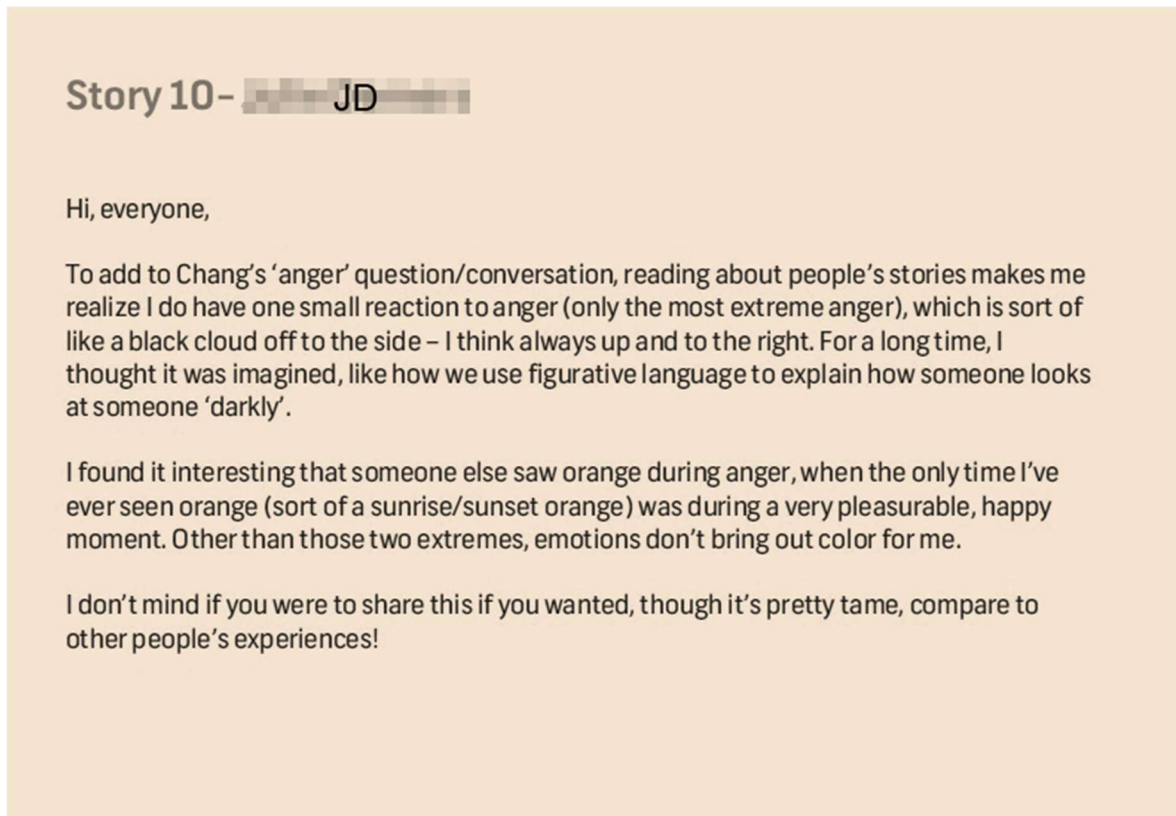


Figure.80 DC's Story Usage 1

DC created a headband (fig.78) specifically for JD. The aim of the headband is to count and work in contrast to her dark cloud synaesthesia experience (fig.80) and make her feel calm. It creates light through a light band whenever she experiences this anger.

This usage of narrative surprised and inspired me, as I had never previously imagined using a synaesthesia story in this way. Indeed, it was a completely different method of using or infusing the narrative compared to my idea (see chapter 5.1.2.2: Prop 2 – Project: Angry Red).

Creation – 7 for Theme 2 (story 13):

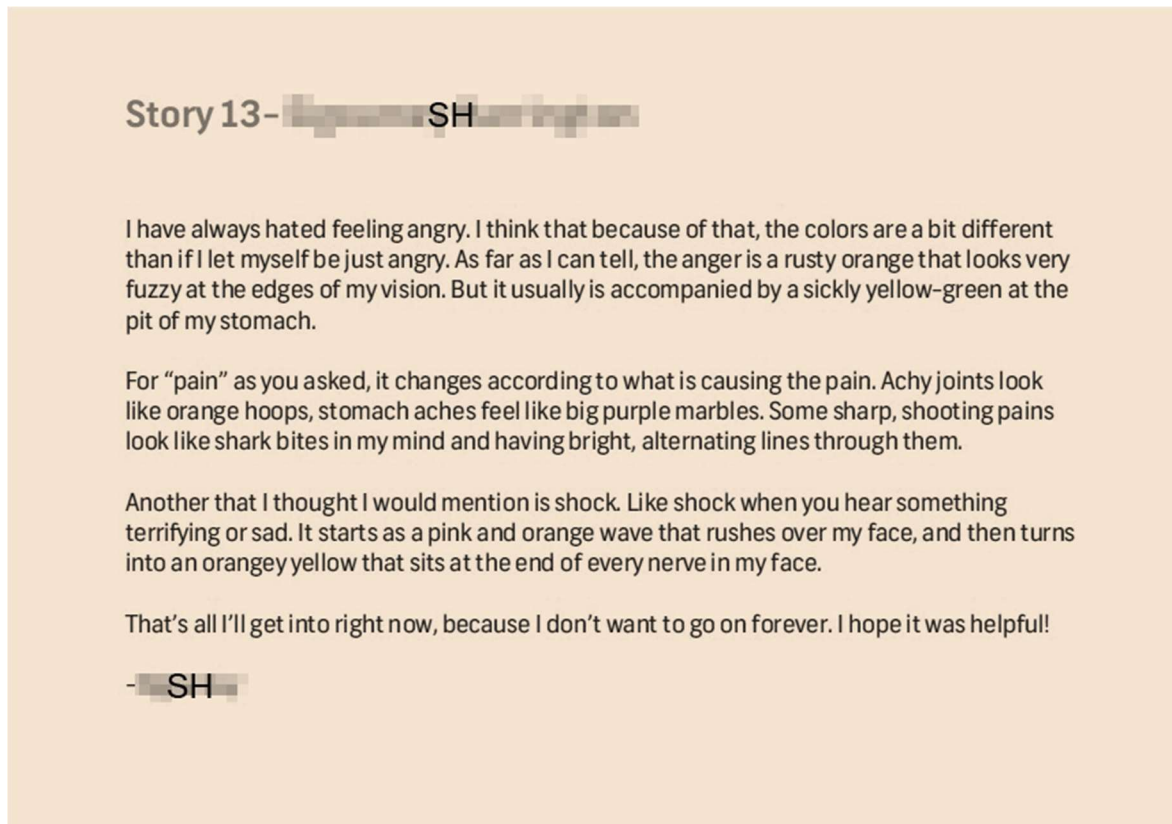


Figure.81 DC’s Story Usage 2

DC was inspired by SH’s different experiences of synaesthesia (fig.78 & 81). He applied SH’s experience to create clothing for children. This clothing shows the current psychological status of children so that people can be more empathetic with them. For example, if a child wearing this clothing feels angry, shock or pain, the clothes may indicate these experiences with LEDs or translate to some other type of output to display their current condition. The clothing’s interactive quality potentially allows other people to look after children with additional care.

DC designed an item of clothing that mimics SH’s experience of synaesthesia. He has used the experience as an indicator to benefit children by adding a context of empathy. This was a very similar way of using a narrative as one of my projects, *Angry Red*.

Creation – 8 for Theme 2 (story 2):

Story 2- CM

One of my earliest conscious memories of a music-color experience was when I got my first iPod at 12 or 13 and listened to it in the dark. Brightness exploded around me in shimmering pinks, whites, and pale green. Often I keep to myself because the noise and crowds of the world can be overwhelming. I don't like it when someone asks me my preference in music since I can't describe it how they would expect. But I've always loved classical music for the string instruments that create ocean waves of maroon and violet. Recently I have tried more energetic genres like EDM, and Dubstep to push the limits of what I thought my brain could experience. In one song, I caught a fleeting image of a glowing green ball inside a three-dimensional box made of gray smoke. As silly as it might sound, this was a truly exhilarating moment.

Figure.82 DC's Story Usage 3

DC proposed a triangle instrument that changes colour depending on how hard people hit the triangle (fig.78). He thought the way that CM describes her experience sounded very intense, and this provoked DC to focus on intensity to create a concept of a hard, striking, effect-related instrument.

PARTICIPANT 2: EG

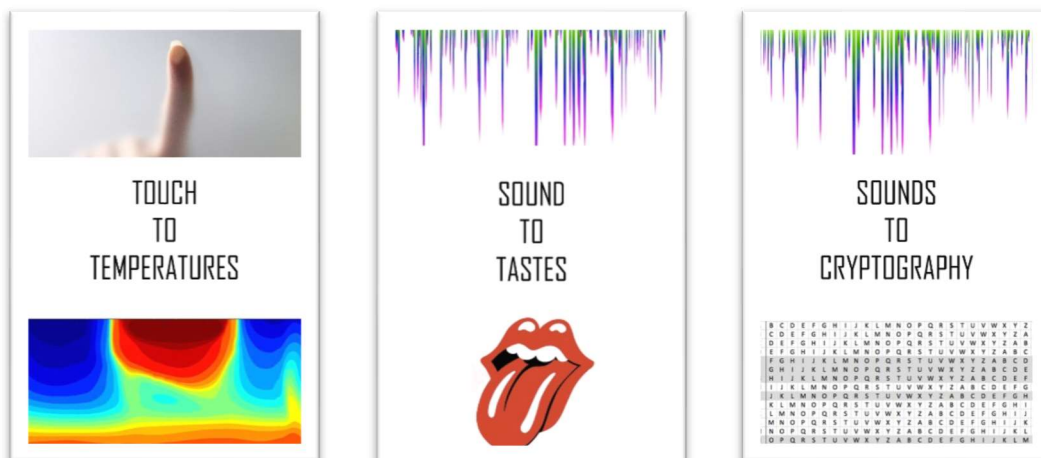


Figure.83 EG's Translation Cards (card-A) Usage

EG used three different translation cards (card-A) (fig.83) and created three ideas in relation to theme 1 (Surprising Birthday Gift), and she used two narratives (fig.84 & 85) to generate ideas for theme 2 (Playful Things). The ideas (below) were written based on a voice recording and my experience of communication during the workshop. Unlike other participants, EG has written her inspirations instead of sketching them.

Creation – 1 for Theme 1 (touch–temperature card):

EG proposed a wrist-band or suit that vibrates to tell you the current weather. This idea was not clearly articulated.

Creation – 2 for Theme 1 (sound–taste card):

EG used the sound–taste card (fig.83) to create a chocolate called the Sound of Silence Chocolate, which is chemically amplified super chocolate that affects our hearing. This chocolate blocks people’s hearing experience, which helps to avoid loud, noisy and annoying situations. The Sound of Silence Chocolate is unbelievably sweet and tasty. By appreciating this enchanted chocolate, the users’ brain can only pay attention to the extreme taste, so they cannot hear their surroundings.

This idea partly used the synaesthetic translation approach but also used the sound–taste card itself as motivation for idea generation. In addition, the card was used bi-directionally, so tastes–sound became sounds–taste.

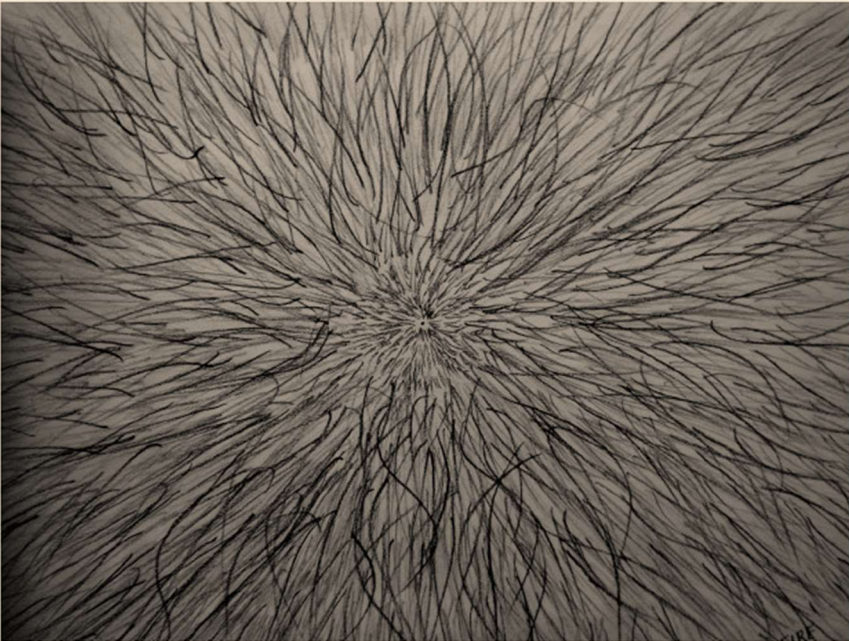
Creation – 3 for Theme 1 (sound–cryptography card):

EG proposed a small artefact that is a collection of memories from different times. This artefact is specifically designed to collect memories by recording sound (any desired sound) and eventually accumulates this as data, thus becoming a collection of sounds that trigger memories of different times. Similar to creation 3, although she mentioned the translation approach was used in this creation, the concept of sound and

cryptography on the card itself gave her primary inspiration in forming the base of this idea. (After the first workshop at the RCA, the cryptography card was removed in Card-B as it was deemed irrelevant in the context of synaesthesia.)

Creation – 4 for Theme 2 (story 3):

Story 3- LG



Hello Mr. Lee,

When I am angry or frustrated, I see something that looks sort of like fire coming at my face (I've attached a drawing I made of it - it's in black and white, but it looks red and orange when I experience it). It is quite painful, and I hear something that's sort of like wind or white noise along with it. If intense enough, I won't be able to see much else for a while, and I won't really be able to think that much for several hours after it's over. I'll either be blank or have thoughts that repeat a lot; especially if whatever went wrong went unresolved. For this reason, I usually try to avoid situations that would cause this.

I'm glad that you are researching this - I've been wanting to contact a researcher about it for a while now (so I can understand it fully, and maybe get an MRI done or something), but I don't really know if inducing something like this for a study would be seen as ethical.

Figure.84 EG's Story Usage 1

By employing a synaesthesia story (fig.84), EG proposed a type of educational programme in jails. LG, who experiences anger-related synaesthesia (fig.84), tries to avoid his extreme sensation of synaesthesia as it may cause him to blank out, and EG wanted to relate this concept of avoiding anger to the idea of punishments for prisoners in jails. She did not talk about any further ideas in detail, but the short discussions were about ways of educating prisoners through some kinds of punishment, so they do not want to feel anger. It was not related to any kind of torture or any other bizarre unethical ideas, but was more about creative discussions related to educating prisoners in jails.

Creation – 5 for Theme 2 (story 3):

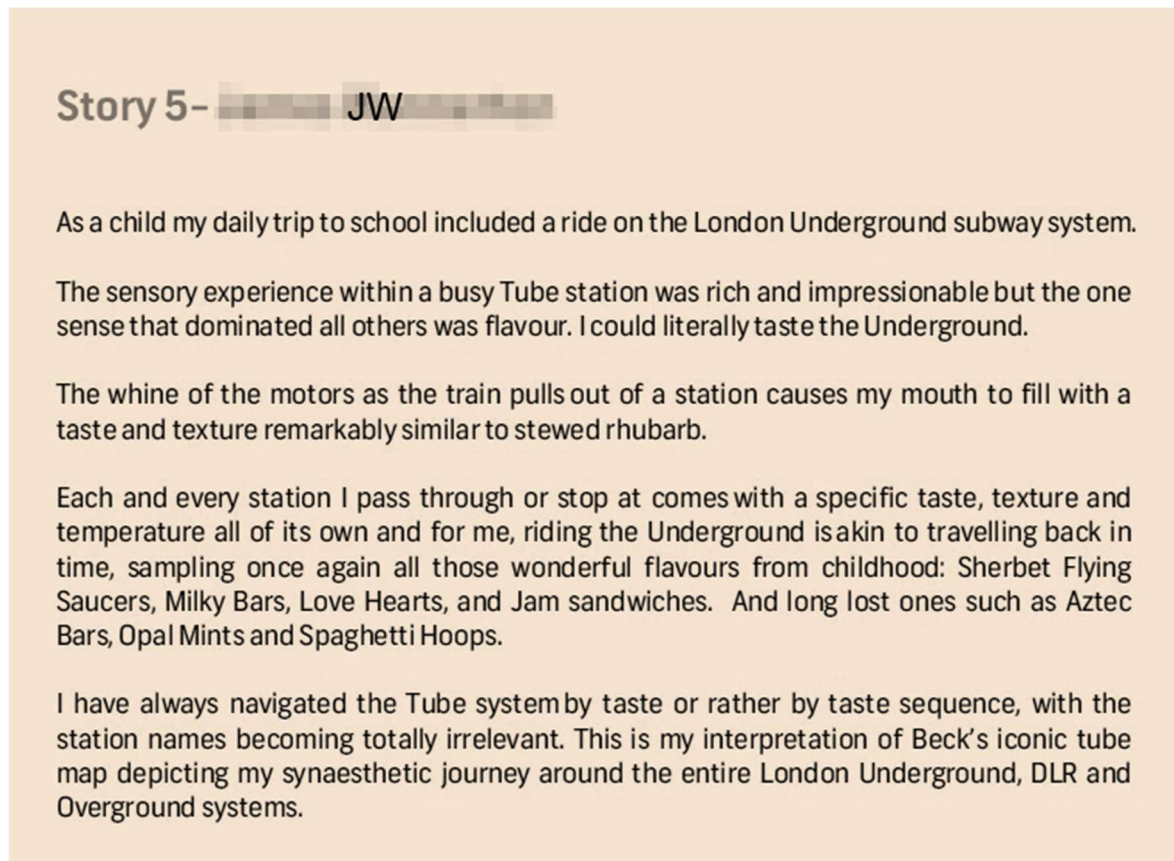


Figure.85 EG's Story Usage 2

One of EG's concepts was inspired by story 5 (fig.85), where JW navigated the London underground tube system by taste or by taste sequence. EG wanted to create an edible music album that provides a taste to each sound pitch through a printed texture-and-

taste map-like album. The idea was simple and straightforward as it was literally about a correlation between music and taste.

PARTICIPANT 3: MS



Figure.86 MS's Translation Cards (card-A) Usage

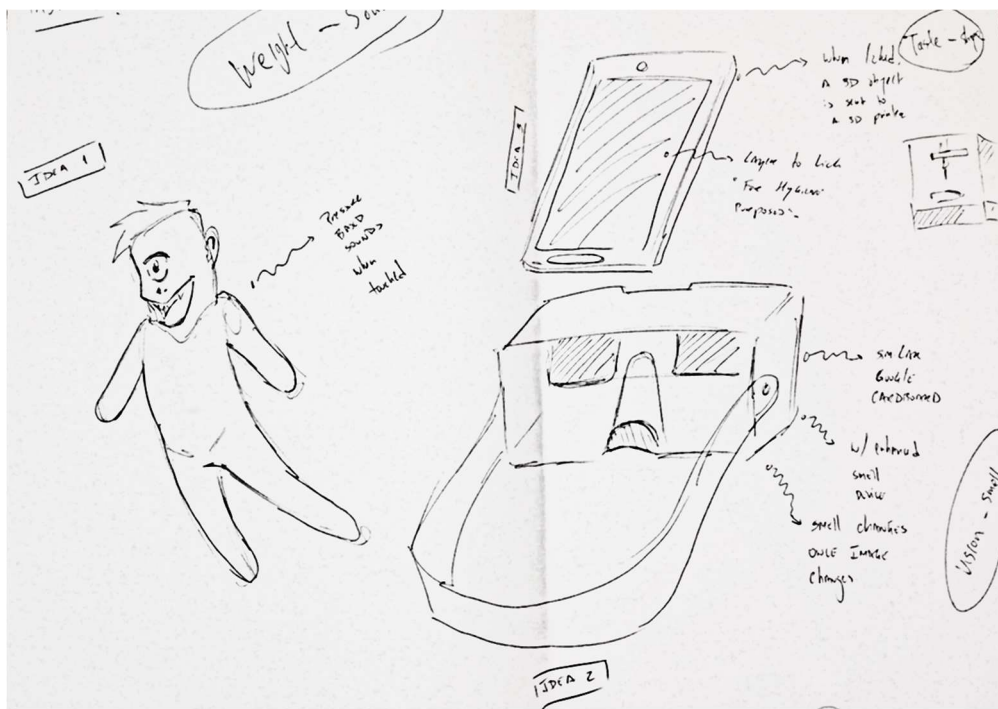


Figure.87 MS's Sketch – 1

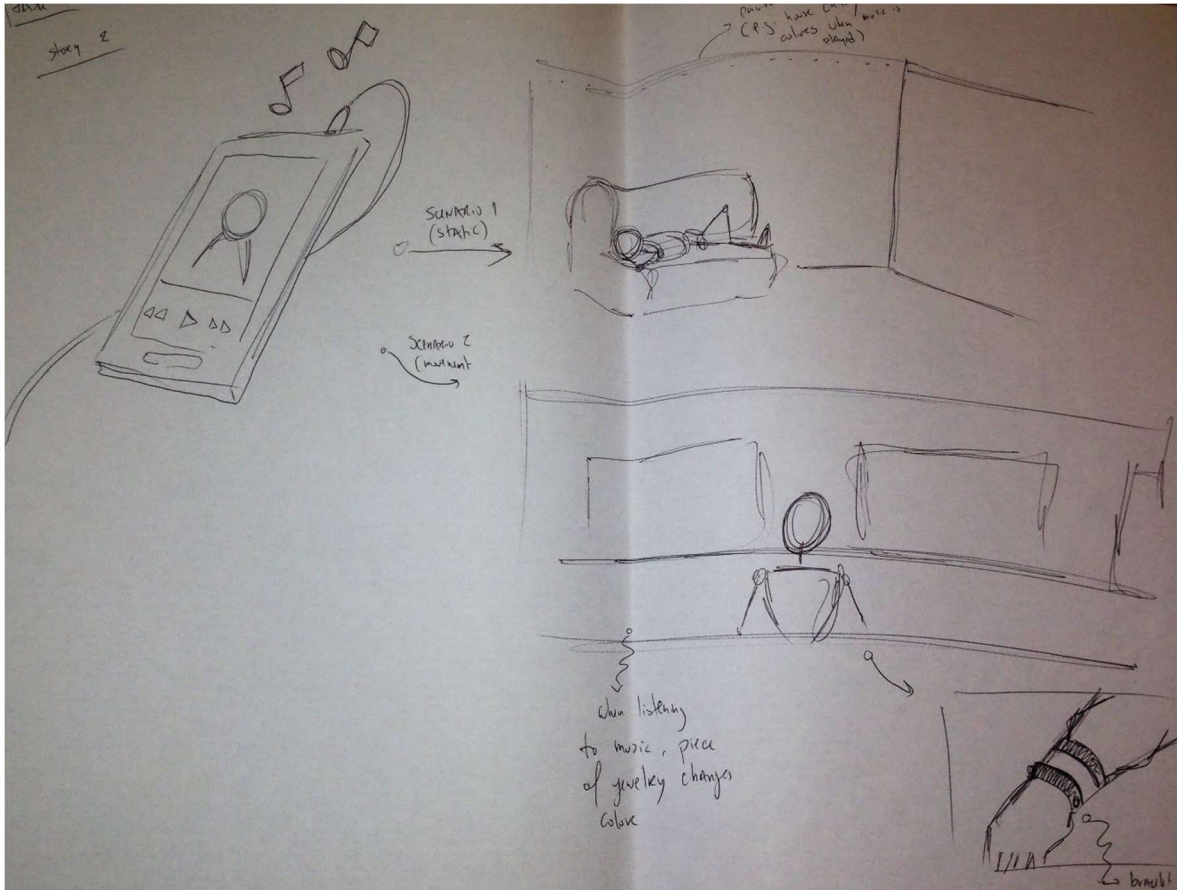


Figure.88 MS's Sketch - 2



Figure.89 Stress Ball

MS has used three different translation cards (card-A) (fig.86) and created three ideas in relation to theme 1 (Surprising Birthday Gift), and used one narrative of synaesthesia (fig.90) to generate an idea for theme 2 (Playful Things). I wrote the ideas (below) based on a voice recording and my experience of communicating with him during the workshop.

Creation – 1 for Theme 1 (weight-sound card):

MS shared an idea of a doll-looking toy (fig.87) that allows people to relieve their stress by squeezing its structure, similar to stress balls (fig.89)³². However, unlike stress balls, this doll creates sounds according to the pressure of squeezing.

Creation – 2 for Theme 1 (taste-shape card):

MS proposed a way of interacting with a mobile phone. This phone device has a unique screen that we can taste when we lick it. This device then sends the information of taste to a 3D printer, which prints out the experience of taste. The idea was very much associated with interface design as he had a background and interest in the field of Human-Computer Interaction (HCI).

While MS's idea of the phone and the 3D printer setup probably went beyond the initial theme of the brief (creating a surprising gift), this kind of snowballing or rapid extension of ideas is not uncommon in idea generation; nevertheless, the taste-shape card inspired a novel concept for a new product system.

³². Stress Ball: A stress ball is a toy, usually around 7 cm in diameter, which is squeezed in the hand and manipulated by the fingers, ostensibly to relieve stress or to exercise the muscles of the hand.

Creation – 3 for Theme 1 (vision-smell card):

This was a creation that is similar to the Google cardboard device (fig.87). MS's idea was to add a tasting and virtual reality technology so people can experience tastes according to the images on the screen. This idea was also covering HCI related elements, and while again going beyond the idea of the gift, the concept demonstrated the potential for synaesthesia-inspired ideas within rethinking interface design contexts.

Creation – 4 for Theme 2 (story 2):

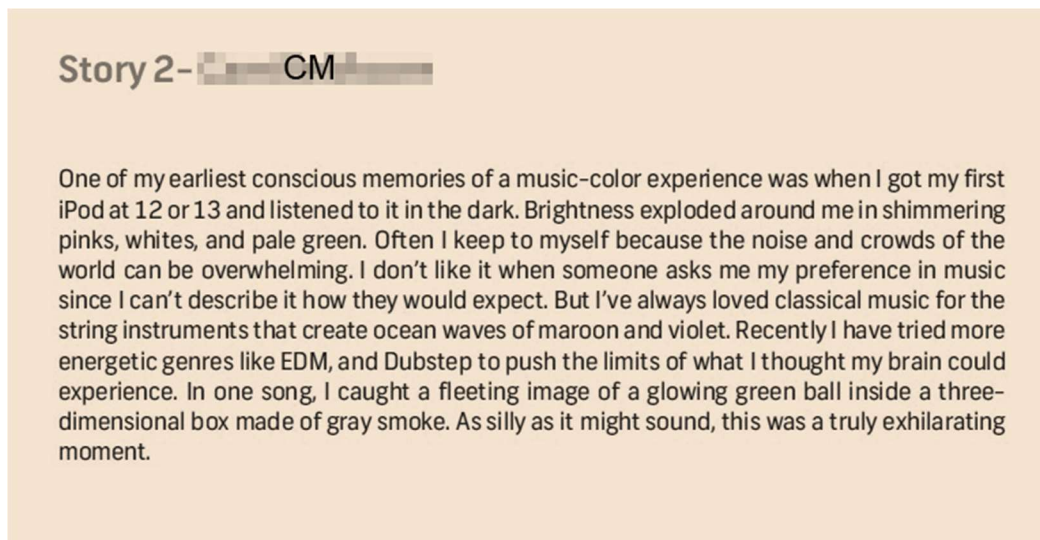


Figure.90 MS's Story Usage - 1

MS came up with an idea of a bracelet (fig.88) that changes colour according to which music someone is listening. This bracelet can be synchronized and shared with other people (partner, friends or family) to communicate their music experience and emotional status. This was a concept that transformed the synaesthesia experience in story 2 (fig.90) into a tangible artefact.

5.3.3.2: Feedback & How Was It Useful?

DC

DC found both the synaesthetic card (card-A) and stories useful. However, he thought they could be improved in a number of ways. He found some of the cards were easier to use as they looked more familiar to him.

- For example, he was familiar with the concept of the touch card due to his strong interest in interface design. This led him to use the touch-smell card to create the idea of a ramen machine, which we later collaborated on to realise the idea. On the other hand, DC suggested that some cards were harder to use. For example, the energy-shape card and the quality-speed card were difficult to understand due to their abstract properties. What does it mean by energy and quality? He was rather confused in interpreting the cards' functionality.
- He added that the translation cards were ready-fixed (e.g. the sound-taste card is fixed to be translated from sound to taste) and that somewhat restricted his exploratory mindset.
- DC commented that he would like to see more interactive features in the workshops. For example, he suggested that participants could engage with interactive items that allow them to experience the quality of synaesthesia, which would help inspire them.
- DC felt much more comfortable coming up with different ideas using stories of synaesthesia instead of the synaesthetic translation cards. He commented that reading through stories of synaesthesia induced him to think synaesthesia-like ideas that facilitated his creative dimension.
- He thought that both cards and stories were useful to some extent in generating creative thinking. The translation card was useful because it offered immediate ready-made insights with the fixed translation opportunity (though the same time -

bound creative dimensions limited accessibility to some extent). He thought the narratives were highly engaging in terms of accessing synaesthesia experience, which he felt helpful in understanding their texture of feeling in detail.

- DC thought the two themes (Surprising Birthday Gift and Playful Things) were very similar to one another, and he suggested it would be better to merge the two.

EG

EG complimented me for a very organised workshop. She was impressed by the workshop environment and told me that it gave her a school-like feeling, which made her feel very safe at the beginning.

- She thought some of the stories of synaesthesia were a little too long to focus on properly, but the shorter ones were playful to read through. She thought some stories were more like derealization of high-level empathy instead of the experience of synaesthesia.
- She commented that both card and story tools were more useful in generating creative discussion than generating specific ideas. The generated discussions may then become a theme for different ideas, such as her ideas related to an educational system in jail (creation 4).

MS

- MS thought the synaesthetic cards were engaging, as he was able to think of certain translative things that he normally would not consider. He commented that he would never have thought of different translative possibilities (such as taste-sha

pe) without the given cards.

- He agreed with DC's opinion regarding the limited features of the translation card. He thought the ready-given translation restricted his thought process and made him narrow-minded.
- MS commented that the stories were rather too long to focus on. This feedback was similar to the feedback received from EG.
- MS thought the two themes were similar to one another (DC also mentioned this point).

5.3.3.3: How Does it Contribute to the Research Questions?

There were plenty of things that I was able to learn through this first workshop at the Royal College of Art. The workshop provided the first opportunity to observe, interpret, listen, uncover and appreciate participants' thoughts regarding my idea of synaesthetic-provocation approaches through my toolkit by applying the two themes (Surprising Birthday Gift & Playful Things). The knowledge obtained throughout this first workshop allowed me to answer **[RQ1]** and **[RQ2]**.

The first agreement within the feedback from the three participants was that the synaesthetic translation card restricts the creative dimension due to its ready-fixed translative approaches. Although one of the participants (DC) commented that this fixed translative feature partly provided immediate insights, all three participants generally agreed that its features were interesting but could be improved upon. This feedback later inspired me to conceive the second version of the cards, card-B, which allows participants to combine their own possible translation (see chapter 5.2.1.3: Card-B). As such, the feedback encouraged me to develop an improved card kit for better accessibility. Therefore, this workshop contributes to **[RQ2]** "*What tools can be created to support these approaches / applications?*"

Some of the long narratives have been removed from the synaesthesia stories tool, as two of the participants (MS and EG) did not feel comfortable using them. However, one of the participants (DC) felt using the narrative was very meaningful in terms of understanding the experience of synaesthesia. Thus, this tool requires further attention and evaluation. This partly embraces **[RQ2]** in terms of the development process of the toolkit. Although this research is not about creating a perfect toolkit for optimal users' experience, it is essential to improve the toolkit to better articulate the idea of the three approaches of synaesthesia-provocation, based on key feedback from participants.

The two themes were merged into one, as their contents were too similar. I was also able to improve the content of the themes with the aid of the participants' feedback, an improvement that contributes to **[RQ2]** in terms of refining the toolkit.

DC's creation 3, the Ramen Machine (fig.77), was a useful example of how the synaesthetic-provocation approaches and toolkit can be used for idea generation and realisation to engage with other people. Creation 3 shows the whole process from the stage of idea generation to project delivery through the synaesthetic-provocation toolkit. The positive feedback and excitement people shared through the realized ramen machine somewhat confirmed to me that the synaesthetic-provocation toolkit and approach are useful in generating appealing ideas in relation to the concept of a playful thing. Therefore, this finding contributes to **[RQ1]** *"How can the characteristics / properties of synaesthesia be used / applied to stimulate creative idea generation and debate?"*

5.3.4: Workshop: Carnegie Mellon University



Figure.91 Remote Workshop at Carnegie Mellon University via Skype

After the first workshop at the Royal College of Art, I re-designed the synaesthetic translation cards (card-B) and deleted the lengthy stories, an adaptation of the material based on the feedback from the first workshop participants. This revised toolkit was then used for a workshop for students taking a unit on designing critically for interaction with AI and algorithms at Carnegie Mellon University's (CMU) School of Design, Pittsburgh. I was able to have this opportunity after communicating with one of my PhD supervisors, Dr. Dan Lockton (fig.91). This second workshop was conducted through Skype, as I was not able to visit United States during that time. The materials (toolkits, task etc.) for the workshop were printed at CMU. The layout for the workshop was similar to the workshop at the RCA except for the provided tools and themes. Although this workshop provided the translation and narrative tools, the narrative tools were rarely used; some participants seem to have completely forget their presence.

INFO OF PARTICIPANTS:

Five undergraduate Design for the Environment students (in their third year of four-year courses) participated this workshop. They were GJ, JT, CP, JTK and TVDZ.

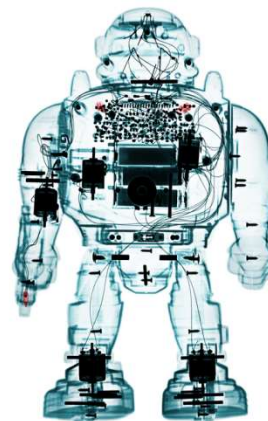
USED MATERIALS:

- Tool: card-B
- Tool: narratives
- Drawing utensils
- Introduction sheet

ADAPTED THEME:

All the participants created ideas in relation to theme 4. This choice of theme was due to the connection between the theme, AI and algorithms course at Carnegie Mellon University.

ROBOT – X



Photographer: Brendan Fitzpatrick



Figure.92 Theme 4: Robot – X

Theme 4: *Robot X does not have the ability to perform any function or to recognise anything. Provide any abilities to Robot X and create your own robot. Think about possible scenarios of how people could interact with this robot. You are free to create any kind of robot, so it could be something like a vacuum cleaning bot, scary bot, musician bot, security bot, dumb bot etc.*

5.3.4.1: Ideas Discussion

PARTICIPANT 1: GJ

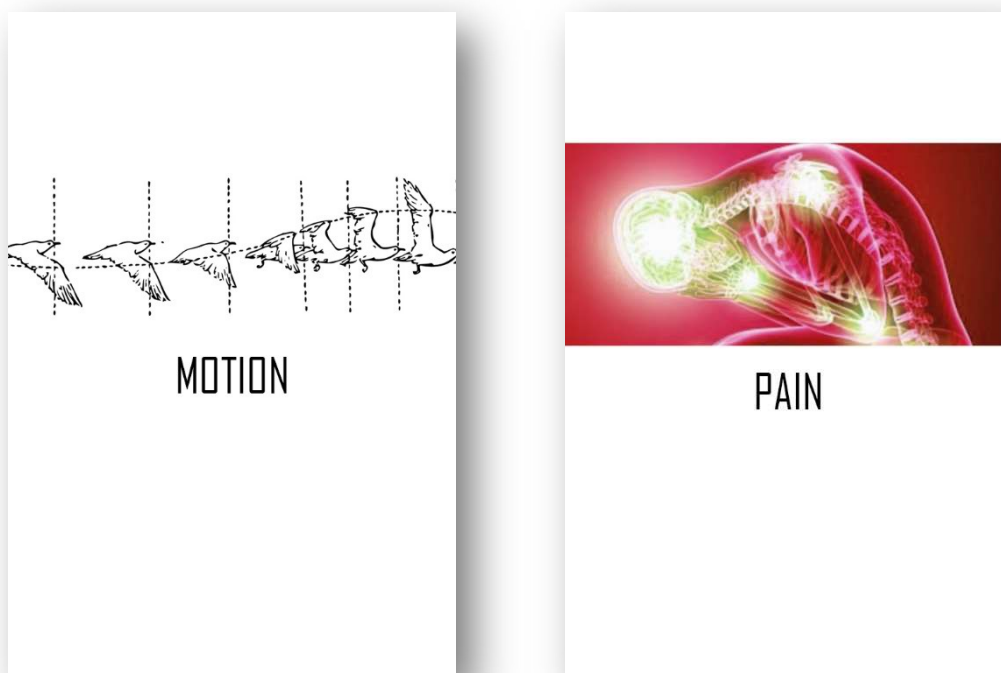


Figure.93 GJ's Combination: Motion to Pain (or vice versa)



Figure.94 GJ's Sketches - 1

GJ created two combination cards with card-B: motion-pain and sound-temperature. She created two ideas through her combination of motion-pain cards, and three ideas through her combination of sound-temperature cards.

Creation - 1 for Theme 4 (motion-pain combination card):

GJ's first combination card was a mix between pain and motion (fig.93). In her card combination, she considered the idea of pain to the concept of shocks (mental or physical) and local or spread pains, and the idea of motion to the concepts of movement, and of air and speed pressure. GJ proposed an experiential sound motion sculpture (fig.94) that translates the pain of users to a certain motion. This sculpture rotates its structure according to the pains of the users. While the idea was not articulated in detail, and did not directly address the sensory aspects of Robot X, the concept of translating pain to motion was interesting, and the idea was also used for another creation below.

Creation – 2 for Theme 4 (motion–pain combination card):

GJ's second creation of robot using the motion–pain combination card was a robot with wheels that mimics human's pain (fig.94). For example, when a connected user feels a pain on one of their toes, one of the robot's wheels may become dysfunctional. If a user feels a pain on his or her back, the robot would mimic this experience and move forward, although the reason for this movement is unclear to me. This rather strange robot was one of the results of brainstorming though card-B, which I liked for some reason. This idea somewhat allowed me to generate far-fetched but interesting imaginative concerns, such as what if a robot becomes a type of surrogate for human pain? What would it be like if a pregnant woman feels zero pain through this kind of robot or pain substitution technology?

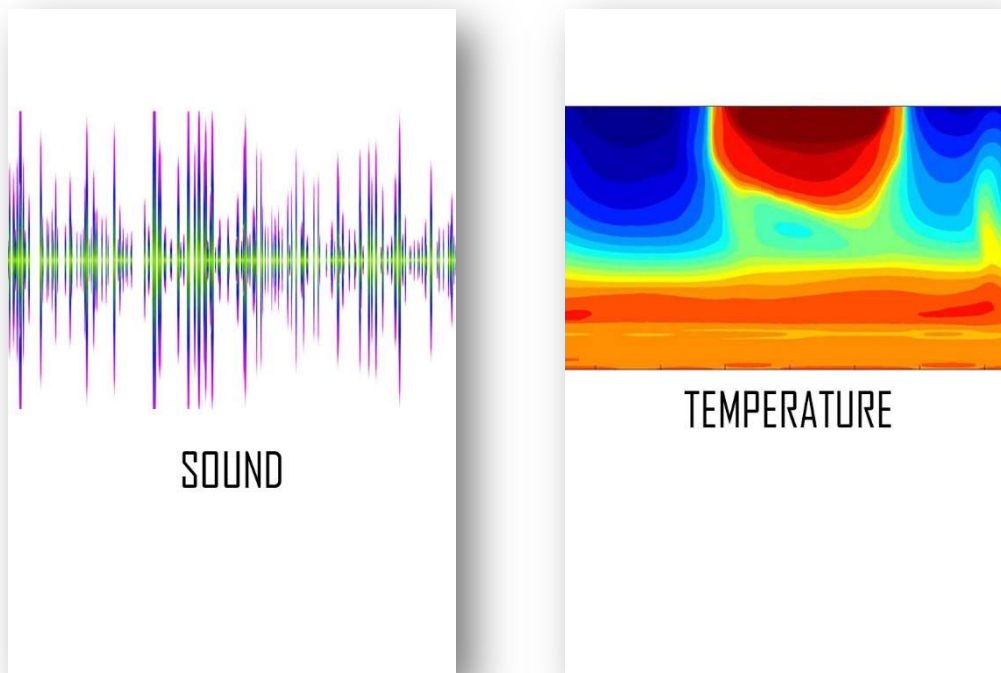


Figure.95 GJ's Combination: Sound to Temperature (or vice versa)

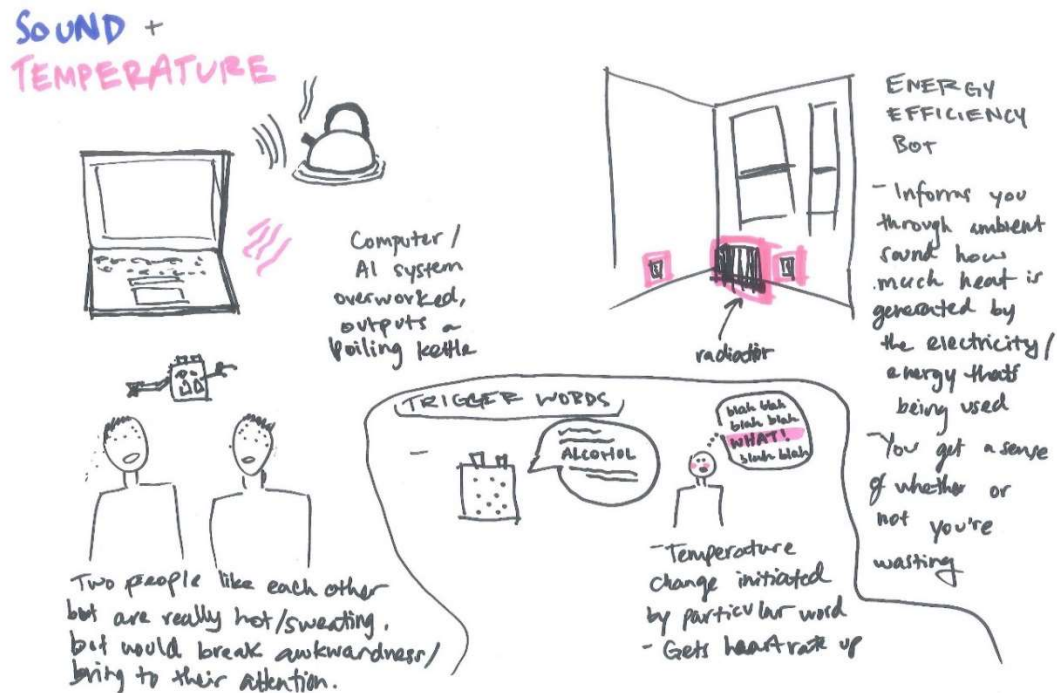


Figure.96 GJ's Sketches - 2

Creation - 3 for Theme 4 (sound-temperature combination card):

GJ's first creation using her sound-temperature combination card (fig.95) was an AI system that tells you that your computer is overworked or overheated by boiling a kettle that produces whistling sounds (fig.96). This system works as an indicator to prevent an overworked computer or any computer related devices. This idea shows well the direct input of the idea of synaesthetic translation.

This creation reminds me of the concept of sonification, where sonification tries to use non-speech audio to deliver information or perceptualized data to provide support for information processing activities of many different kinds (Barrass and Kramer, 1999).

Creation - 4 for Theme 4 (sound-temperature combination card):

GJ's fourth creation was a rather humorous robot that serves as an ice breaker for people (fig.96). For example, two people are dating for the first time and there is an awkward moment in the conversation, because they are unfamiliar with each other. This robot

suddenly bumps in and breaks the awkwardness between the two people by telling them, “You two are both sweating a lot, haha, don’t be too nervous!” through sensing their temperature. This rather uncanny idea of robot was inspired by the characteristics of two different cards rather than the idea of synaesthetic-translation.

Creation – 5 for Theme 4 (sound-temperature combination card):

The fifth creation was an energy efficiency robot that translates the usage of energy to ambient sounds. The created sounds make one aware of how much energy is being wasted. This function of robot embraces the idea of data sonification, just like GJ’s other creation (creation 3).

PARTICIPANT 2: JT

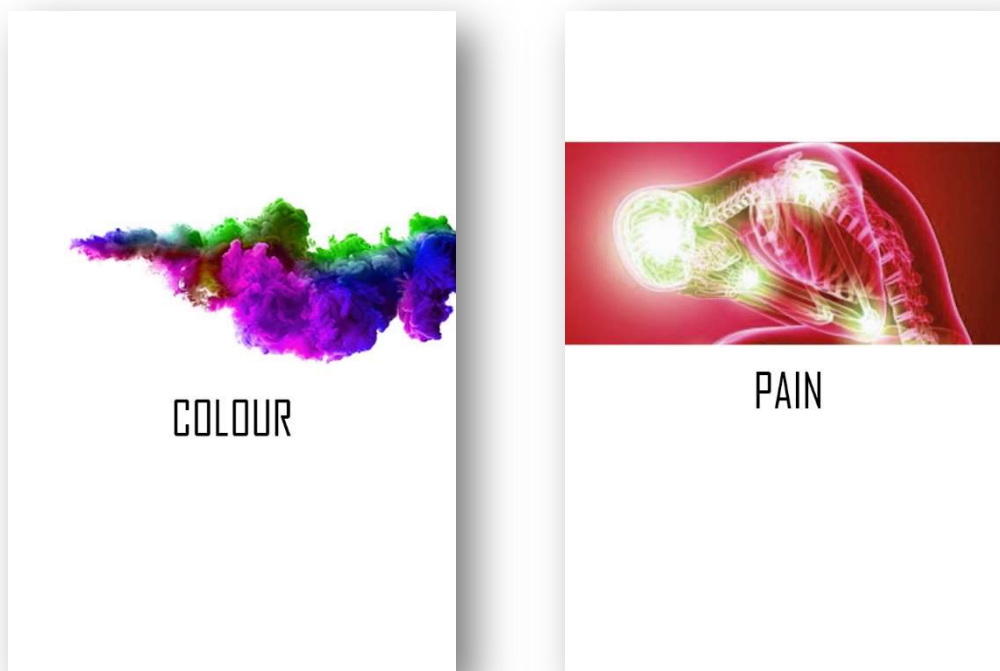


Figure.97 JT’s Combination: Colour to Pain (or vice versa)

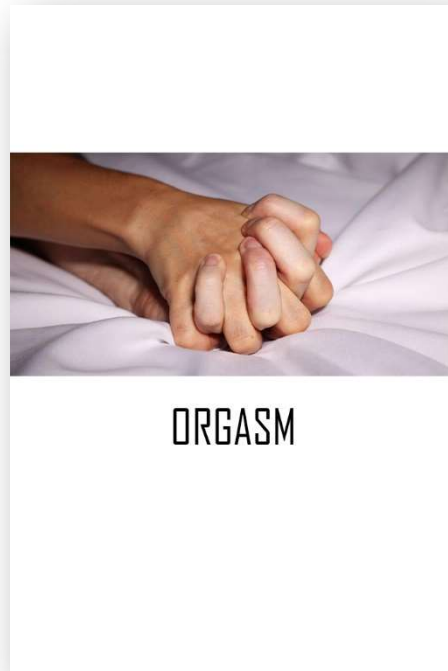
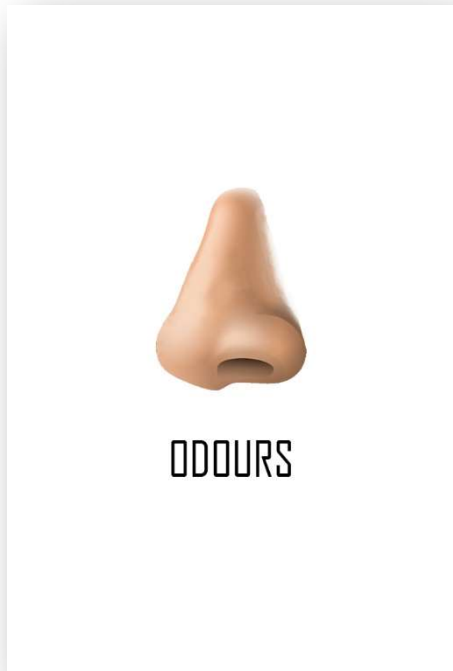


Figure.98 JT's Combination: Odours to Orgasm (or vice versa)

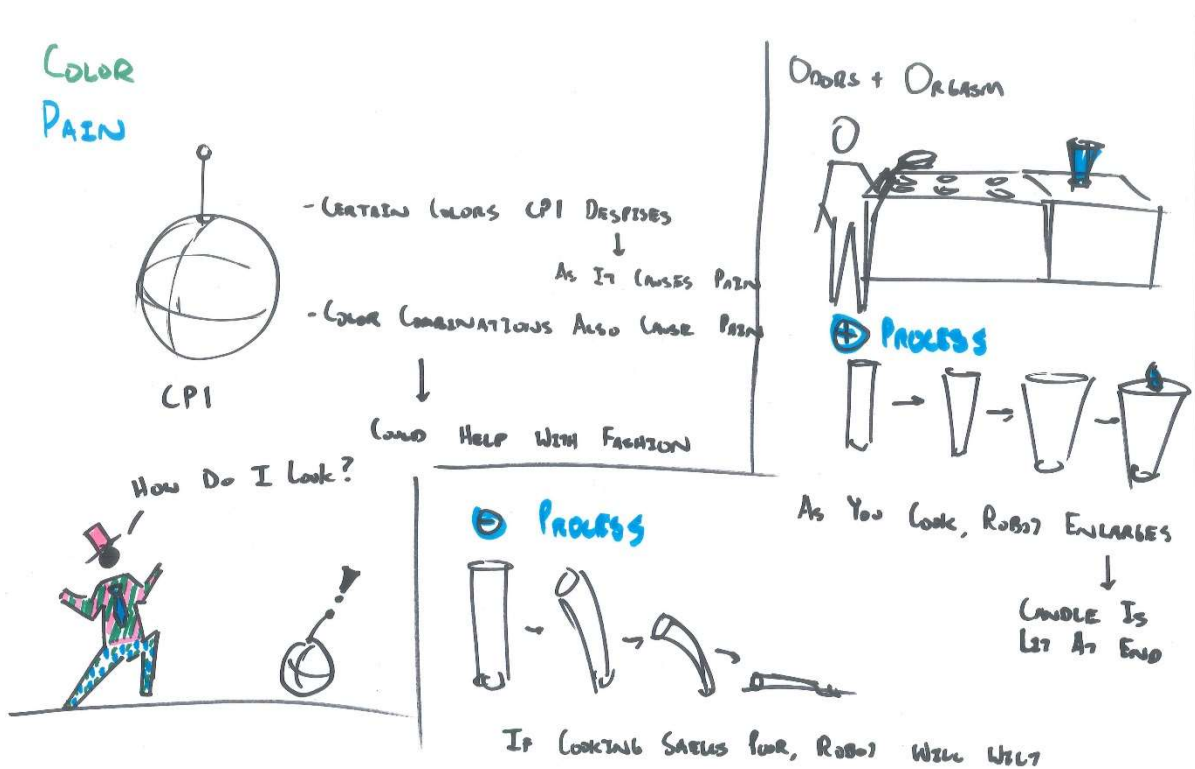


Figure.99 JT's Sketches – 1

Unlike GJ, JT created seven creations using seven different combination cards. They are the combinations of colour-pain, odours-orgasm, speed-stress, energy-sound, time unit-anger, personalities-temperature and colour-taste cards.

Creation – 1 for Theme 4 (colour-pain combination card):

The first creation by JT was a ball-type rolling robot (fig.99) that can help people with fashion by detecting colours. This robot has an extreme sensitivity to fashion and feels pain or shock if it discovers a human wearing bad-looking unbalanced clothing. The robot's response, or feedback, enables people to re-consider their clothing for better styling options. It is a strange bot, and offers an unusual interaction between users and AI.

Creation – 2 for Theme 4 (odours-orgasm combination card):

The second robot creation was a cylinder type robot that helps to evaluate whether users are cooking their meal very well. The idea was inspired by the translative possibility between two cards: odours and orgasm (fig.98). This robot gradually enlarges or grows in size by smelling the process of cooking. If someone nearby is cooking well (smelling good), this bot will increase its body and, if the cooking is not going well, vice versa. The robot lights up an LED or a candle if the meal smells fantastically good.

I was more inspired by how he considered the relationship between odour and taste. As I have mentioned above, although flavour comes from the combination of odour and taste information of the chemosensory regions of the brain, does a food with appreciable smell guarantee the best taste? JT's idea made me consider the potential risk of absolute evaluation in the judging process of a robot or AI within the complexly interacting world.

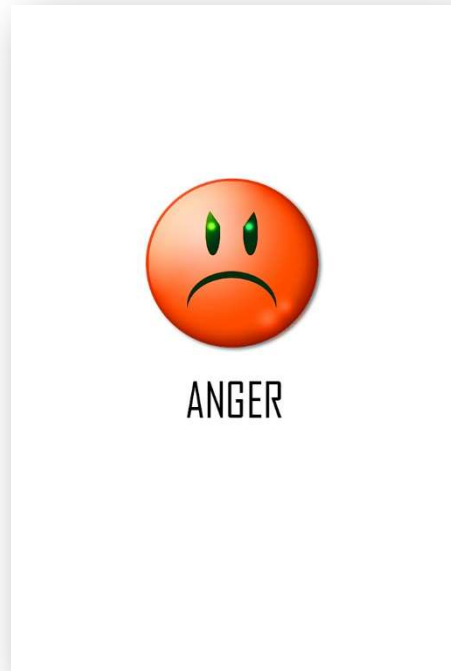
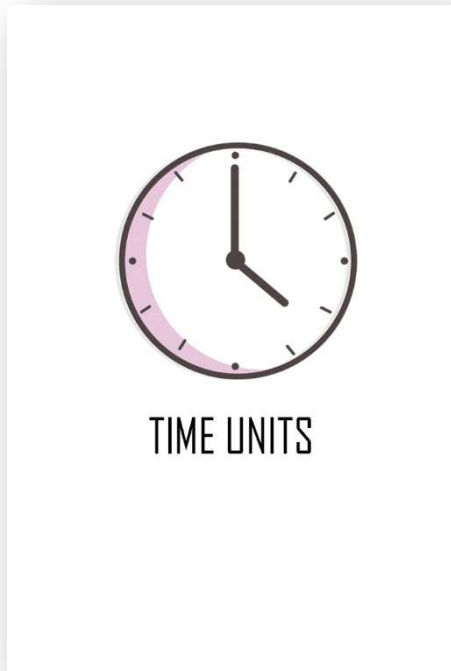


Figure.100 JT's Combination: Time Units to Anger (or vice versa)

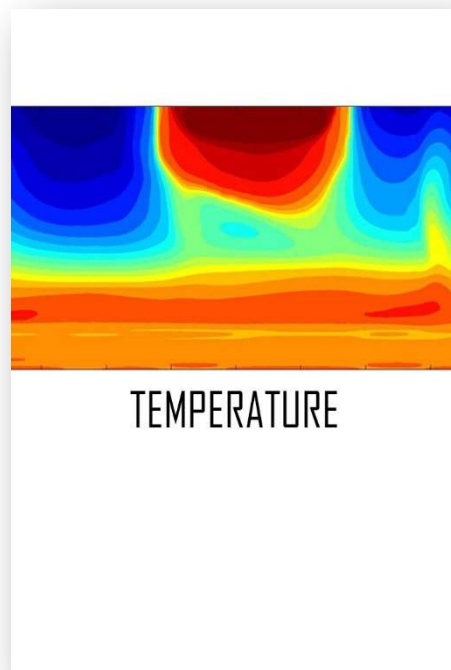


Figure.101 JT's Combination: Personalities to Temperature (or vice versa)

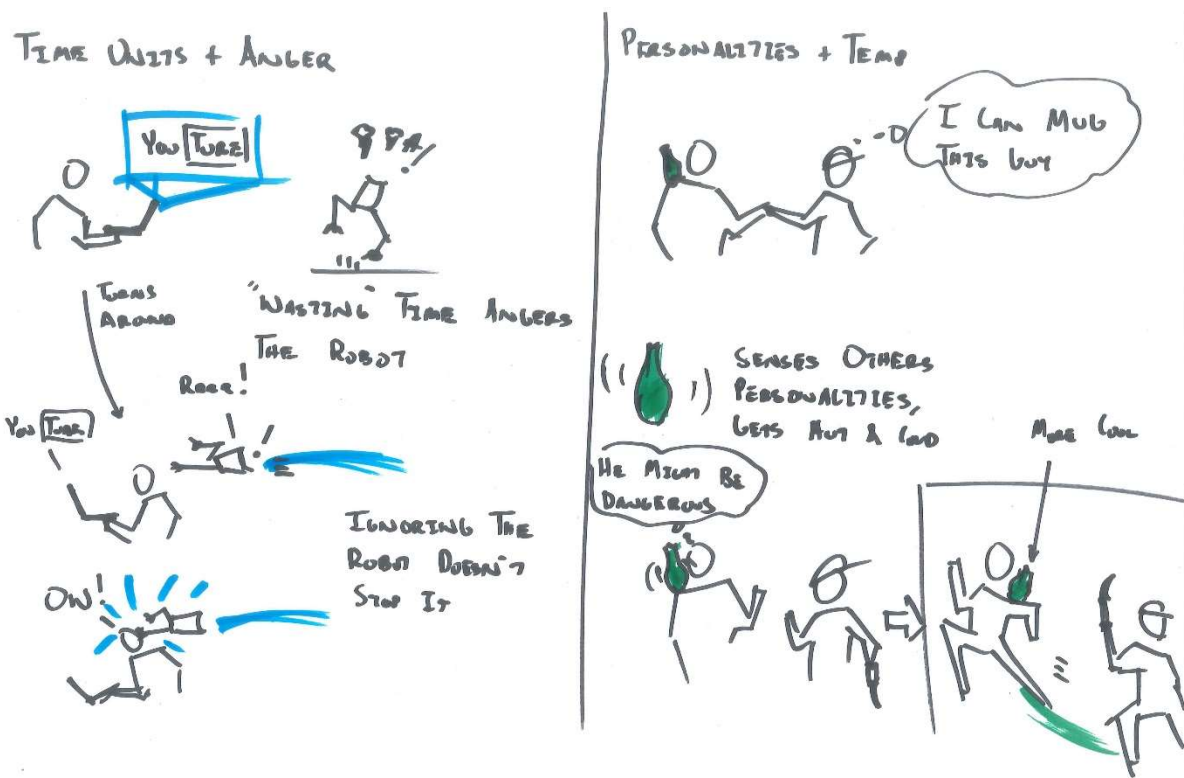


Figure.102 JT's Sketches - 2

Creation - 3 for Theme 4 (time units-anger combination card):

This third robot creation by JT was inspired by his experience of wasting time on the internet and the time units-anger combination cards (fig.100). This robot experiences anger if its owner wastes too much time surfing the internet (e.g. Youtube and social media). This robot makes you aware if you are wasting too much time and, if the accumulated anger (time) goes too far, it provokes a violent reaction from the robot, such as kicking its owner from the chair.

This rather playful scenario of robot led me to consider whether my toolkit is particularly useful in generating playful ideas. Some of the previous creations by GJ (creation 2 & 4) were also relatively playful, bouncy or perhaps novel in some respects, due to their unexpected functionalities.

Creation – 4 for Theme 4 (personalities-temperature combination card):

This fourth creation was a mini robot that hangs on your shoulder to help detect other people’s personalities through temperature. For example, a person tries to mug the owner of the robot, but this robot detects the impending robbery and notifies the owner of the dangerous personality by indicating changing its body temperature (fig.101 & 102).

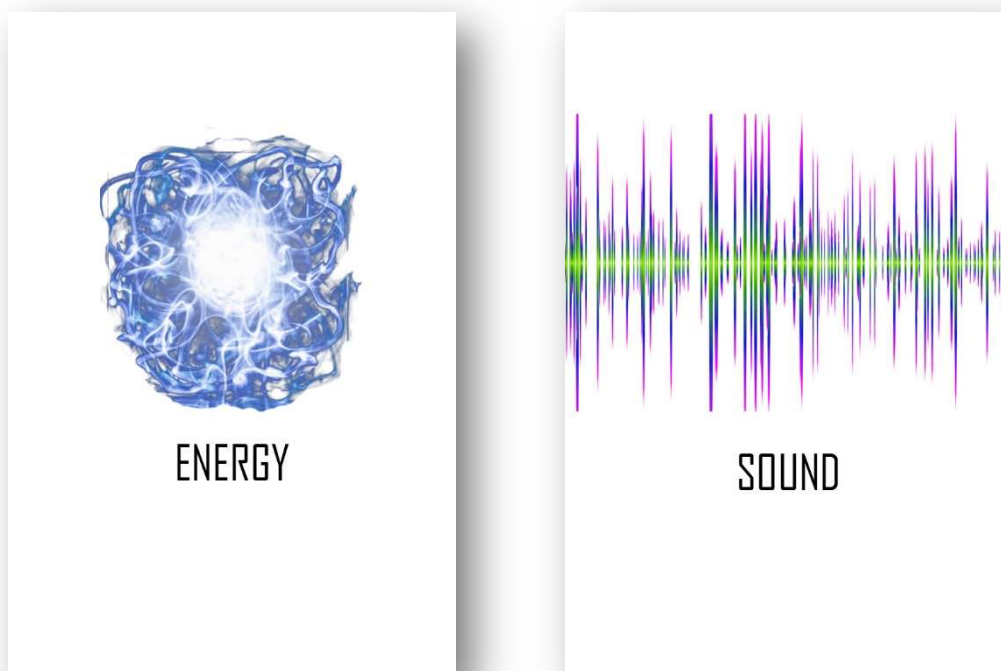


Figure.103 JT’s Combination: Energy to Sound (or vice versa)



Figure.104 JT's Combination: Colour to Taste (or vice versa)

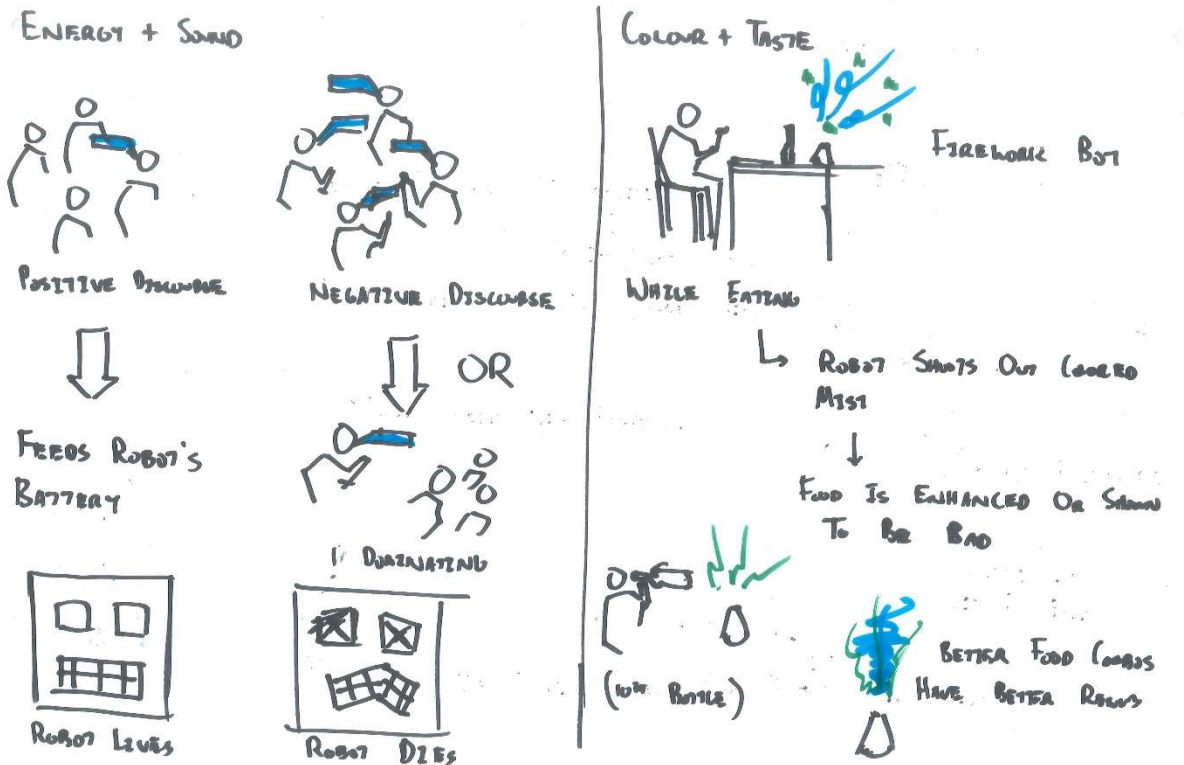


Figure.105 JT's Sketches – 3

Creation – 5 for Theme 4 (energy-sound combination card):

JT has created a sound charging robot by combining the sound and energy cards (fig.103 & 105). This robot does not simply charge itself with sounds, but only charges when it hears positive discourses or debates. However, the robot discharges and dies out when in an environment where the sounds are of negative discourses (such as one person dominating a conversation). JT humorously imagined creating a robot that allows people to shape balanced and positive discourses during conversations.

Creation – 6 for Theme 4 (colour-taste combination card):

JT created a brief idea about a little bot that sits on a table and creates a mist or firework to enhance the taste of foods (fig.105). It provides different mists or aromas according to the food in front of him.

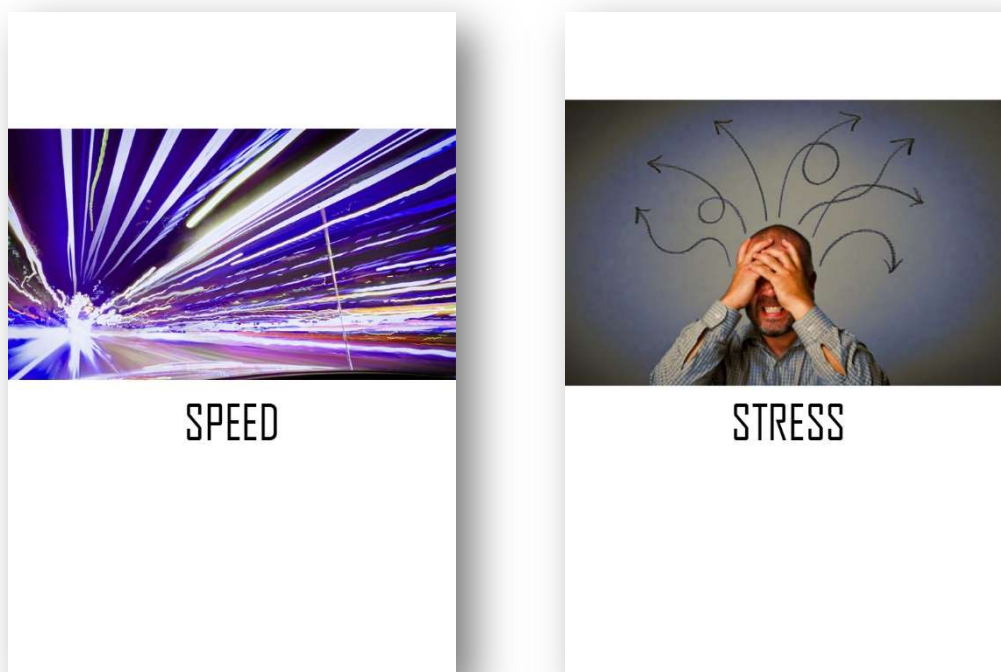


Figure.106 JT's Combination: Speed to Stress (or vice versa)

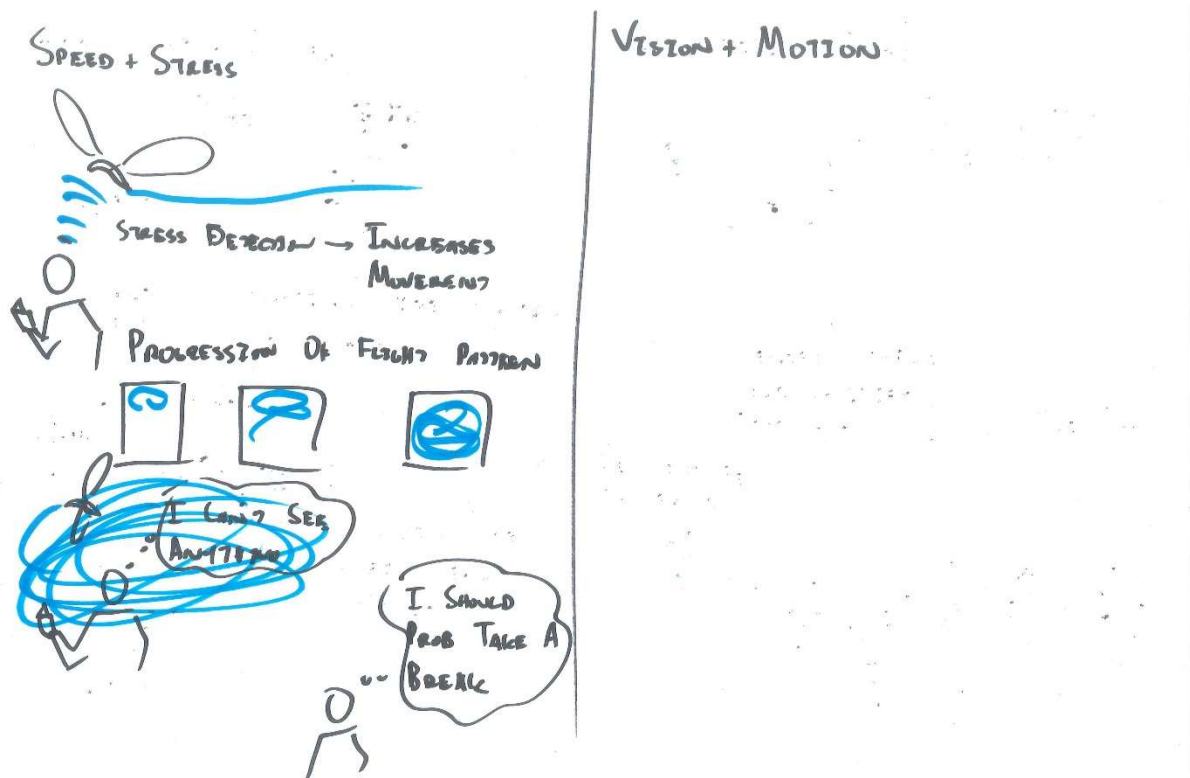


Figure.107 JT's Sketches - 4

Creation - 7 for Theme 4 (vision-motion combination card):

The final robot creation by JT was inspired by a combination between the speed and stress cards (fig.106). This robot flies around a room and detects the user's stress and moves faster when the user's stress level is higher. For example, if a person in a room is reading and working intensely, this robot perceives this stress and flies faster to tell its owner about their current stressful status (fig.107).

PARTICIPANT 3: CP

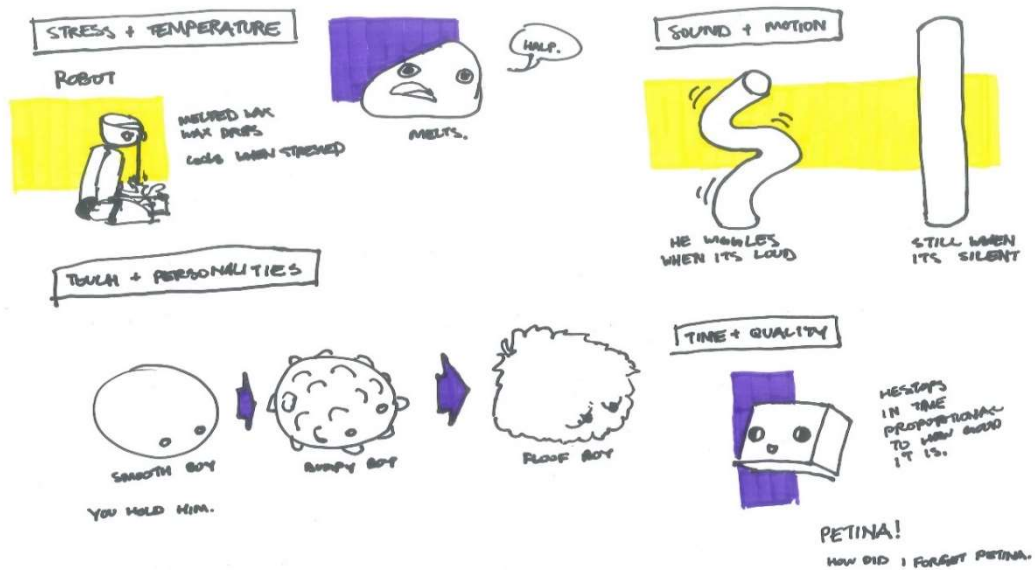


Figure.108 CP's Sketches

CP created four different concepts of robot by creating four different combination cards. They are stress-temperature, sound-motion, touch-personalities and time-quality cards.

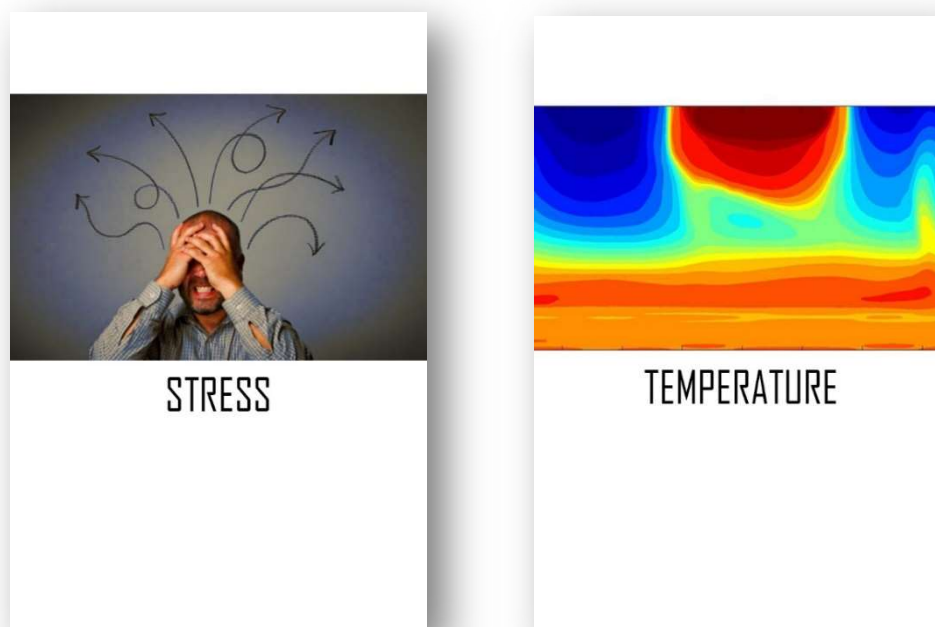


Figure.109 CP's Combination: Stress to Temperature (or vice versa)

Creation – 1 for Theme 4 (stress–temperature):

CP’s first creation was a humanoid robot that detects users’ stress levels (fig.108 & 109). This humanoid bot has a head made of frozen wax. However, whenever it detects user’s stress, the wax head begins to melt and eventually disappears after repeated or constant stressful experiences.

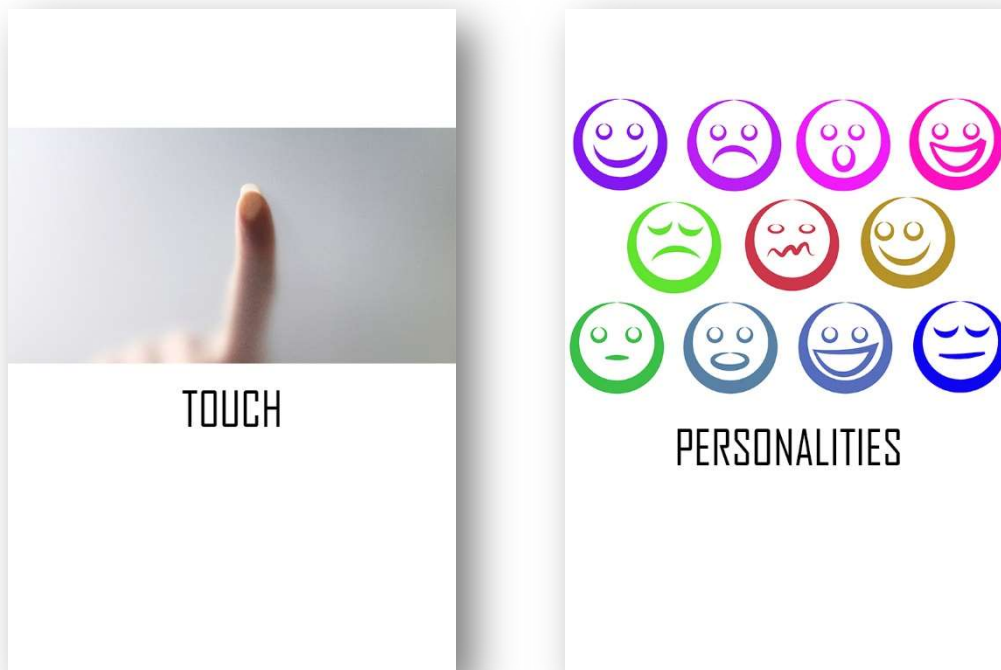


Figure.110 CP’s Combination: Touch to Personalities (or vice versa)

Creation – 2 for Theme 4 (touch–personalities):

This is a shape-shifting robot that transforms its surface depending on how people touch and behave with its surface. It can react and change its form or shape from a smooth to a fluffy texture (fig.108 & 110). This robot does not have any particular characteristic, but the way that CP considered the idea of personality through texture was thoughtful in a way. What are the relationships between personality and texture?

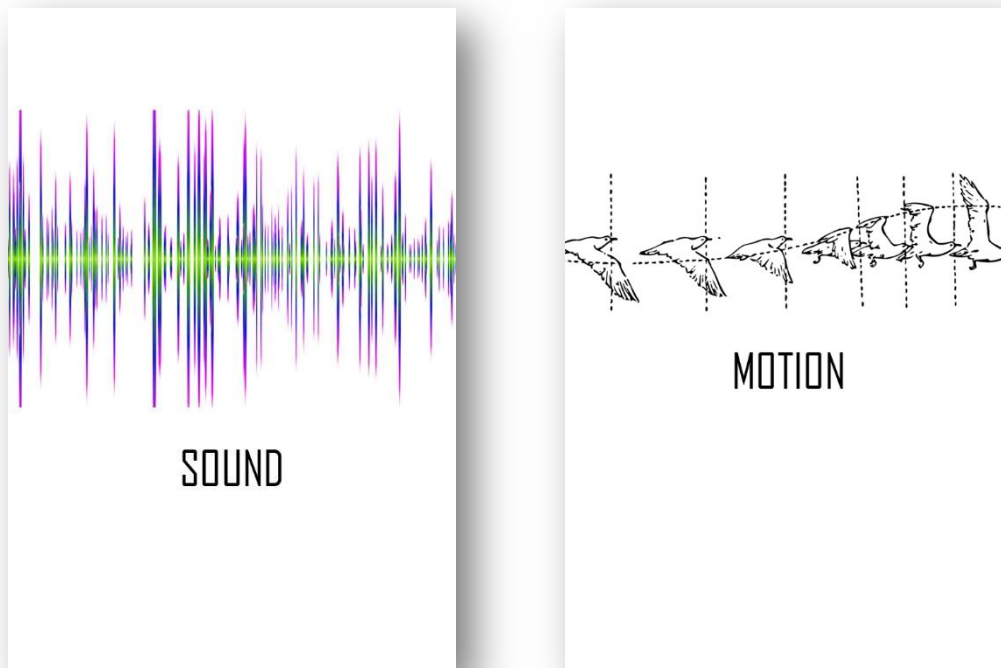


Figure.111 CP's Combination: Sound to Motion (or vice versa)

Creation – 3 for Theme 4 (sound-motion):

This robot wiggles if it hears a noise or loud sound in the environment (fig.108 & 111). It twists and shakes its cylinder-looking body as a reaction to the sounds, although the specific reason for this reaction is not elaborated. This sound-motion combination by CP gave me a similar impression as the creations by GJ (creations 3,4 & 5). This may be because they both used the sound card for their creative combinations, which makes me think that anything that is associated to the sound card links to the idea of sonification due to its possibilities in data to sound translation.

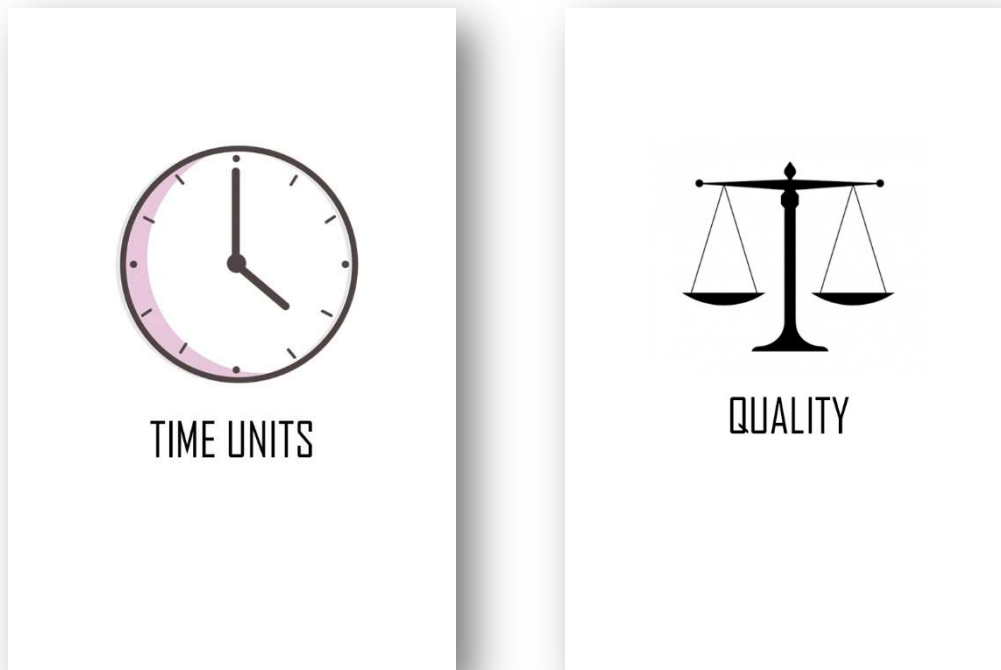


Figure.112 CP's Combination: Time Units to Quality (or vice versa)

Creation – 4 for Theme 4 (time–quality):

The final creation by CP was an intriguing bot that can appreciate and discern a certain quality of something. This robot usually wanders around, but immediately stops or freezes itself whenever it faces an exceptional value or quality (fig.108 & 112). For example, if one unleashes this robot in a museum, let us say in Tate Modern, this robot will probably freeze for a long time in front of exceptional artworks, due to the astonishing quality of paintings or other artworks. If we can perfectly calculate every quality around the world through absolute numerical form, what would possibly happen? How are we perceiving and feeling the texture of quality around the world? This rather silly, playful, ridiculous robot stimulated many random thoughts regarding the concept of quality.

PARTICIPANT 4: JTK

JTK created seven different ideas using seven different combinations of cards. They are odour-personality, vision-graphemes, spending-temperature, time unit-pain, stress-weight, orgasm-colour and energy-taste. JTK was one of the participants who ignored the theme, Robot-X, and freely created concepts in relation to his own concerns. He also created his own combination of card: spending-temperature.

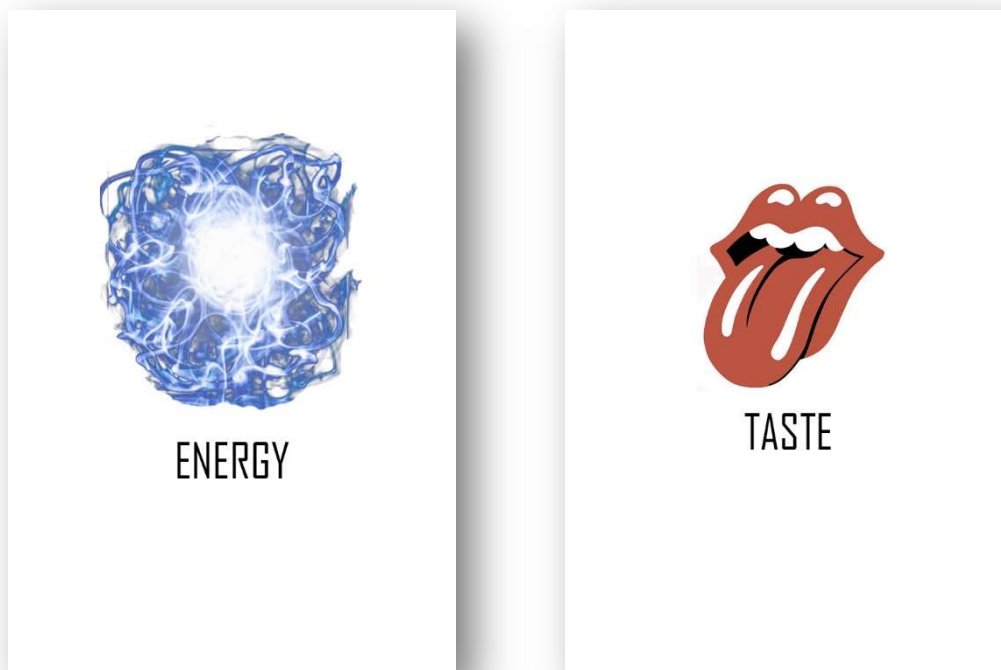


Figure.113 JTK's Combination: Energy to Taste (or vice versa)

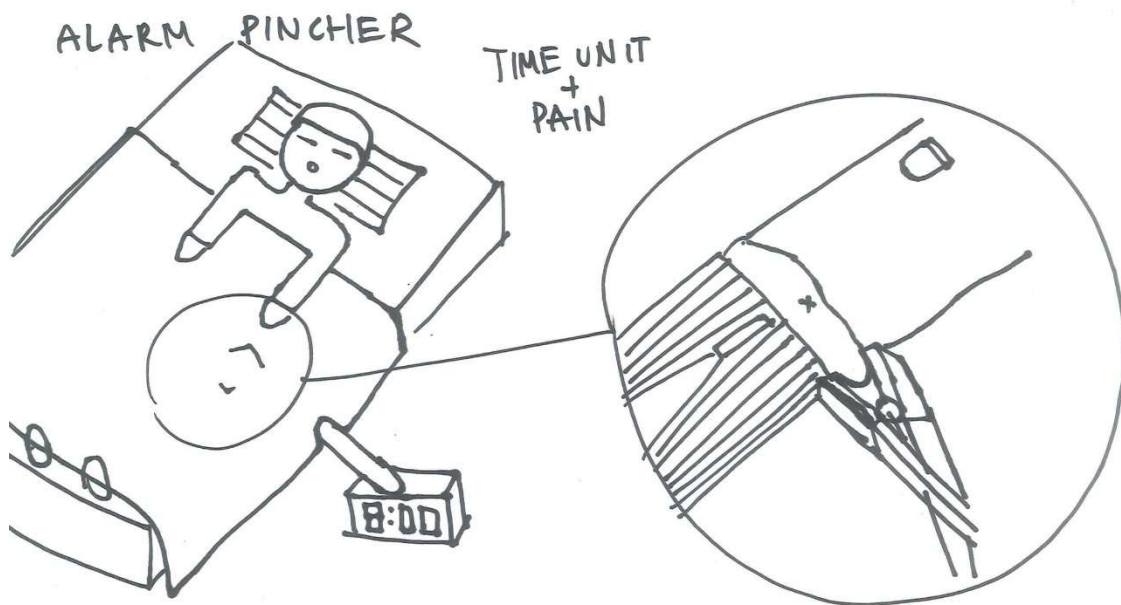


Figure.114 JTK's Sketches – 1

Creation – 1 for Theme 4 (energy–taste):

JTK shared a concept of a chopstick for better communication that reveals your partner’s current mood or feeling while having a meal together (fig.113 & 114). This chopstick drops a sour sauce into your meal if your partner is not in a good mood. This sour taste will work as an indicator, so you can treat them better and try to make them happy. On the other hand, this chopstick drops a sweet sauce if the partner is feeling good. This strange idea may enhance the communication between the two people. In this brief concept, the idea of energy (fig.113) seems to associate with the notion of happiness.

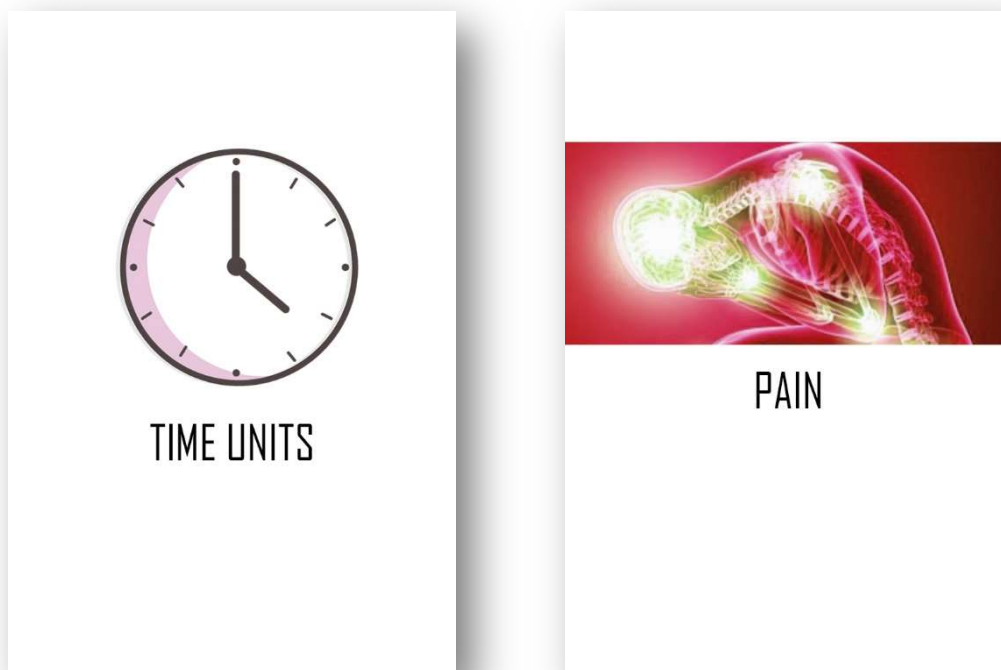


Figure.115 JTK’s Combination: Time Units to Pain (or vice versa)

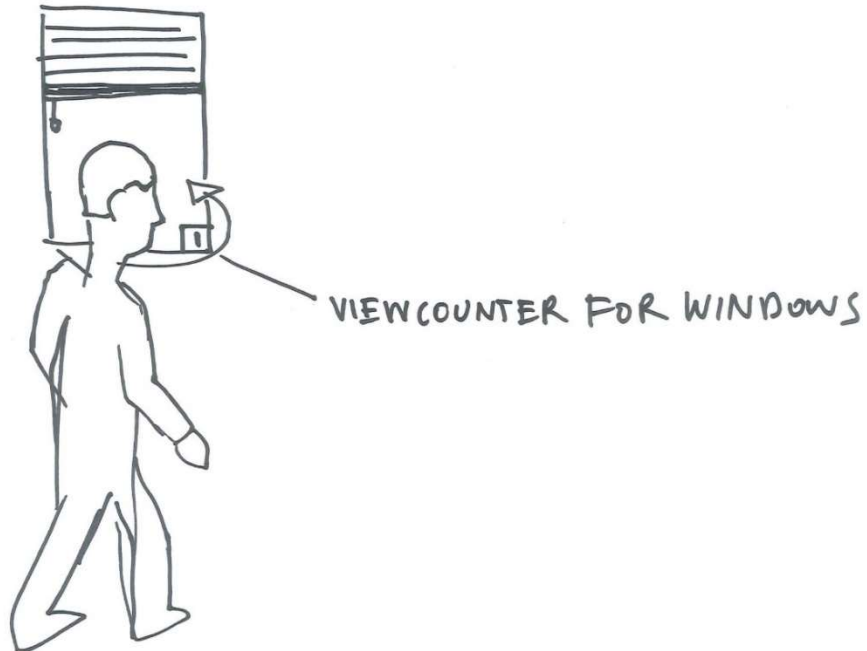
Creation – 2 for Theme 4 (time units–pain):

This alarm pincher wakes you up by pinching your body (fig.114). This idea seems to be clearly inspired by each card (fig.115) rather than the direct synaesthetic translation, as the two functions work separately from one another.

ODOUR + PERSONALITY



VISION + GRAPHICMES



SPENDING + TEMPERATURE

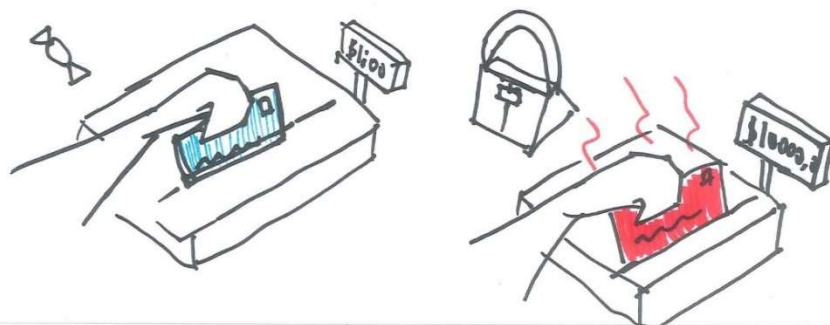


Figure.116 JTK's Sketches - 2

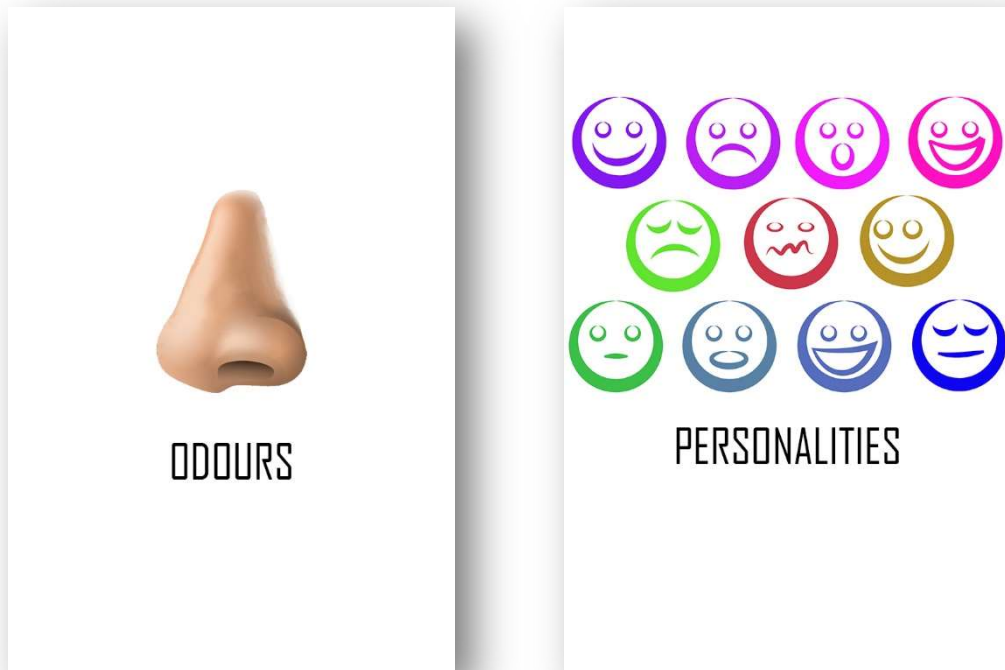


Figure.117 JTK's Combination: Odours to Personalities (or vice versa)

Creation – 3 for Theme 4 (odours–personalities):

JTK imagined a software rating system or interaction method that allows users to create pungent, bad smells to their eBay sellers when they are given a low rating. For example, if your seller gives you a rating with one star (fig.116), which is the lowest feedback you can give on eBay, this device will dispense some sort of unpleasant smell on the seller's face, as an expression of the buyer's negative experience and feeling.

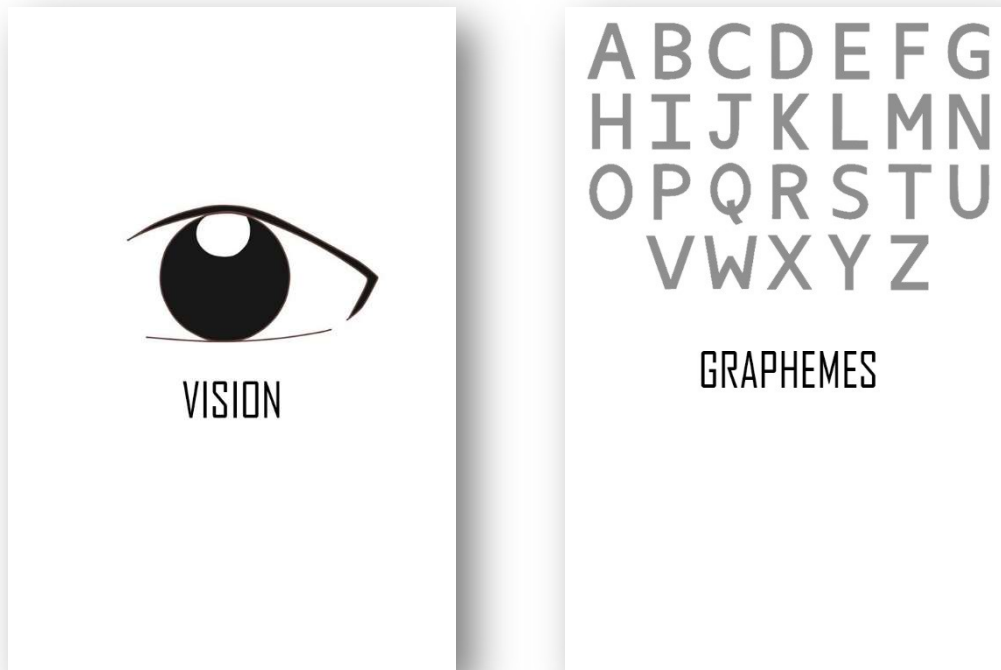


Figure.118 JTK's Combination: Vision to Graphemes (or vice versa)

Creation – 4 for Theme 4 (vision-graphemes):

By combining vision and graphemes cards, JTK created a little device that allows you to check your concentration status. This interesting, tiny device is installed near the window, and whenever a user views outside the window, this device counts the number of views and functions as a view counter (fig.116).

Although this device would not be able to examine or sense your concentration status precisely, it shares the possibility and excitement of creating an initial technology of observing our concentration status, which I found fairly interesting and valuable.

We may use sensors to capture raw information from the world. However, interpreting how to use and adapt this information in a certain context is far more important than just gathering data. For example, when we have to check to see if someone has a fever, we do not use a fever sensor or a sickness sensor, but we use a temperature sensor (Bernate, 2015, p.19). As such, exploring the usefulness of the raw data within a specific context is

an essential aspect to consider. I consider learning how to implement this data to establish sense, logic and quality is one of the key roles of a designer.

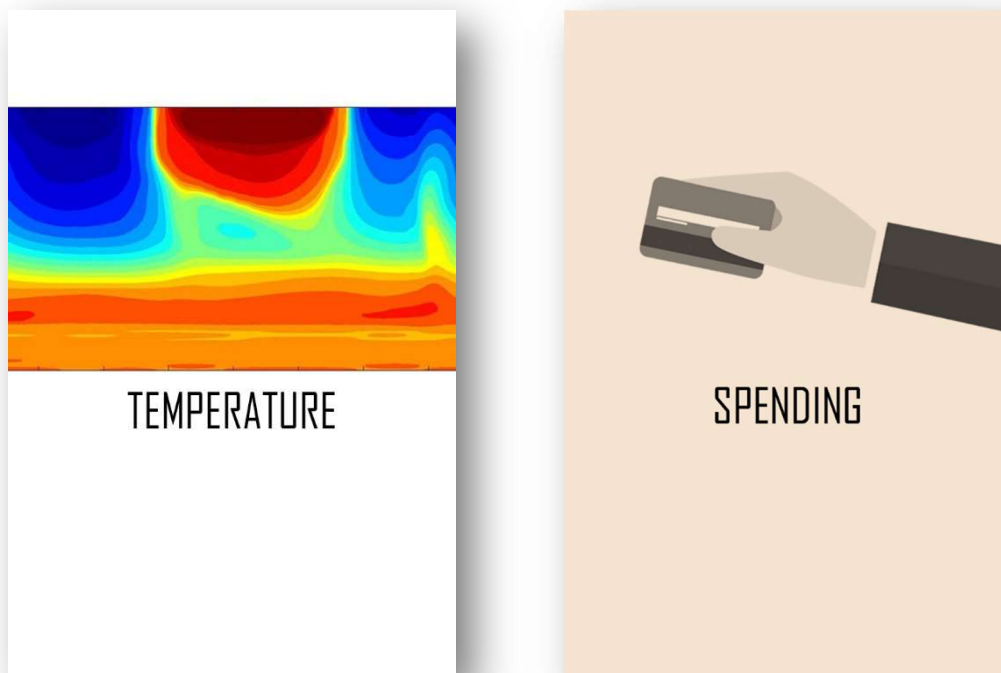
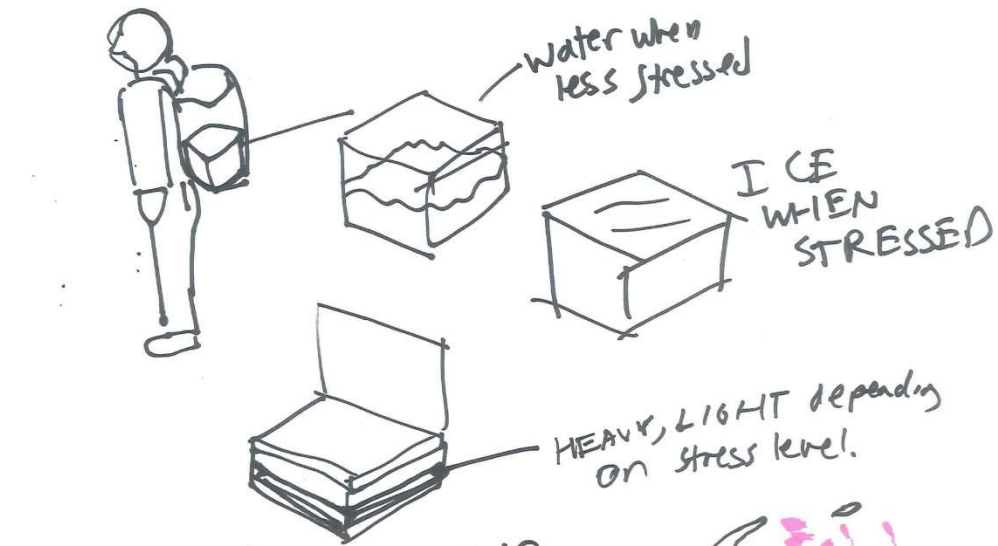


Figure.119 JTK's Outside Combination: Spending to Temperature (or vice versa)

Creation – 5 for Theme 4 (spending-temperature):

The idea of the fifth creation was a credit card that tells you the amount of money you are spending. This card changes its temperature to indicate to the user if they are spending large amounts of money (fig.116). JTK's process in the fifth creation was different compared to any other creation. This difference was due to his way of using the cards, as he did not combine them with the provided card kit. Instead, he created one of his own "spending" (fig.119) cards and combined it with the temperature card (fig.119). His method could be a clue that the translation card-B enables people to think of different translation possibilities than those provided on the existing format of the translation cards. As I have mentioned above, JTK was one of the participants who did not follow the theme (Robot - X), but also the one who created his own card for idea generation.

STRESSWEIGHT



ORGASM + COLOUR

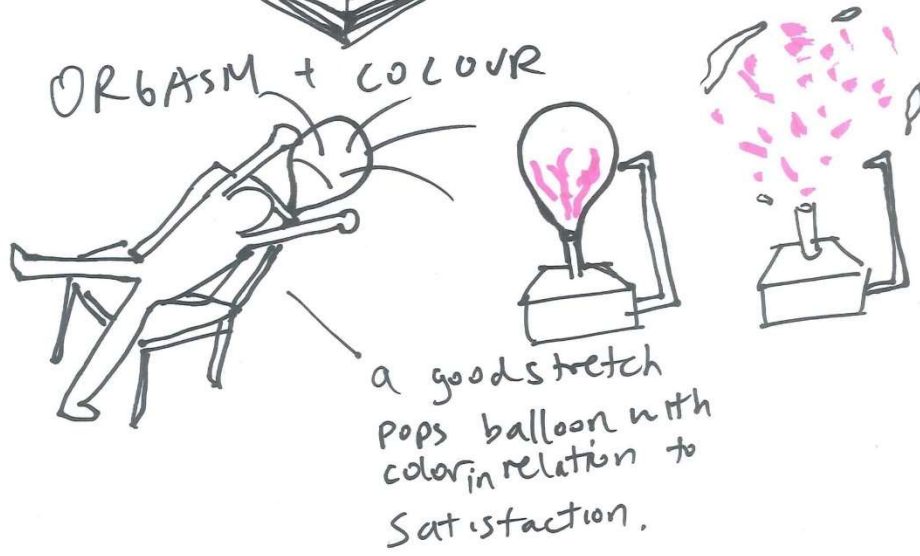


Figure.120 JTK's Sketches - 3

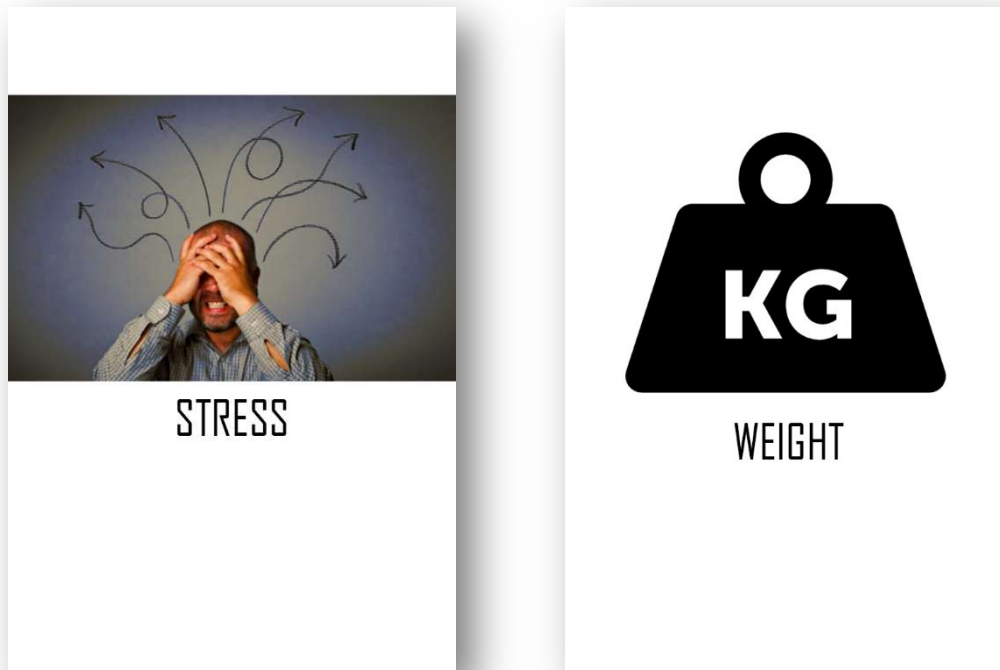


Figure.121 JTK's Combination: Stress to Weight (or vice versa)

Creation – 6 for Theme 4 (stress-weight):

For the sixth creation, JTK proposed a bag that becomes heavier or lighter depending on the user's stress. There is water container under the bag and it freezes if the user is very stressed (fig.120 & 121). JTK was not very pleased with this idea and explained this creation in less than five seconds.

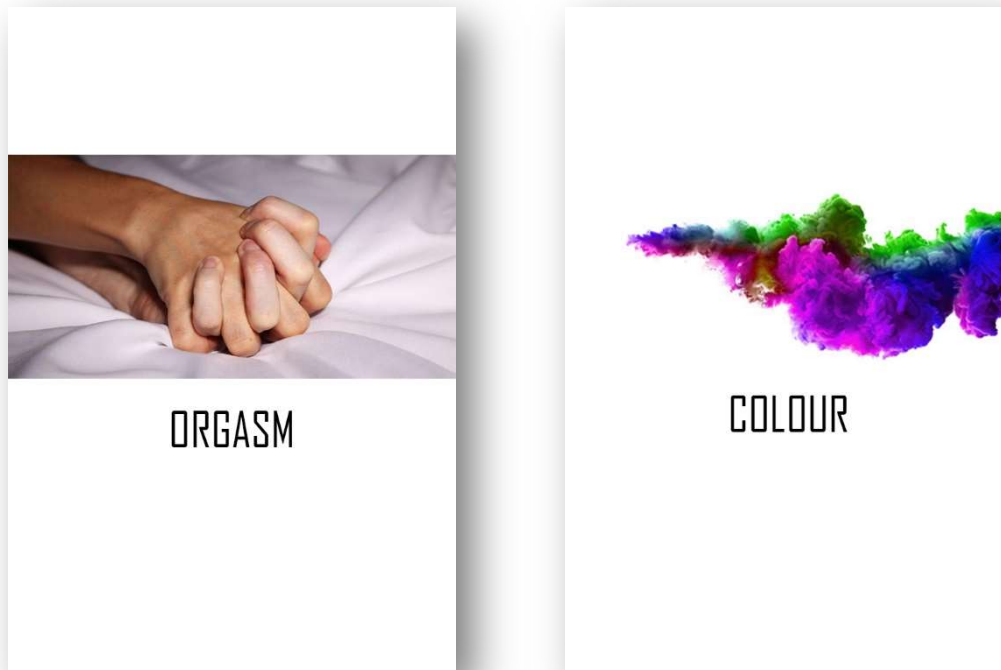


Figure.122 JTK's Combination: Orgasm to Colour (or vice versa)

Creation – 7 for Theme 4 (orgasm-colour):

The final creation by JTK was an idea that came up from the combination between orgasm and colour cards (fig.122). The design was an unusual chair (fig.120) device that detects your stretching and pops up a balloon with a certain colour when your stretch reaches to your peak satisfaction level. JTK considered the excitement of stretching as some sort of orgasm.

PARTICIPANT 5: TVDZ

TVDZ created three robot ideas using three different cards: colour-motion, colour-energy and colour-personalities. TVDZ's creations of robot associate to one another and cooperate to work together. His approach was rather different compared to the other participants. TVDZ looked more into the characteristics of a robot than its functionality. Each robot also has its own name.

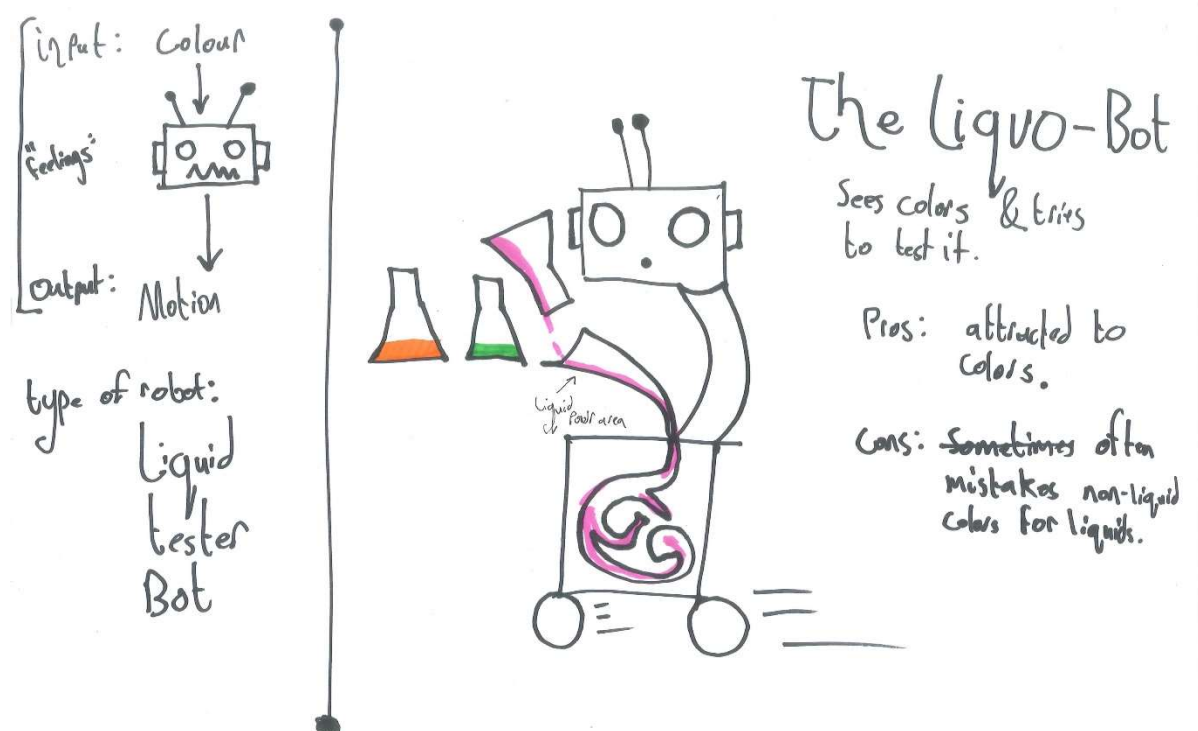


Figure.123 TVDZ's Sketches - 1

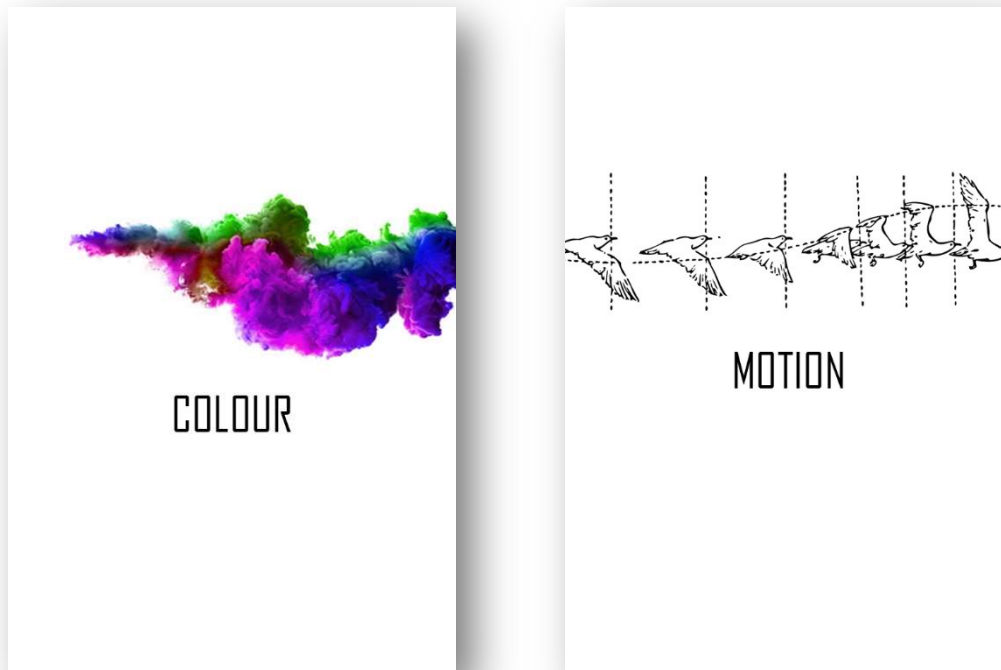


Figure.124 TVDZ's Combination: Colour to Motion (or vice versa)

Creation – 1 for Theme 4 (colour-motion):

LTB (Liquid Tester Bot) (fig.123 & 124) is a strange robot that fails to detect coloured objects filled with liquid, although it is called a liquid tester bot. This robot looks for coloured objects in the room, approaches them and tests something. Nobody knows what the LTB is testing, but it just keeps trying to observe coloured objects while exploring the space. This robot feels very comfortable in a colourful environment.

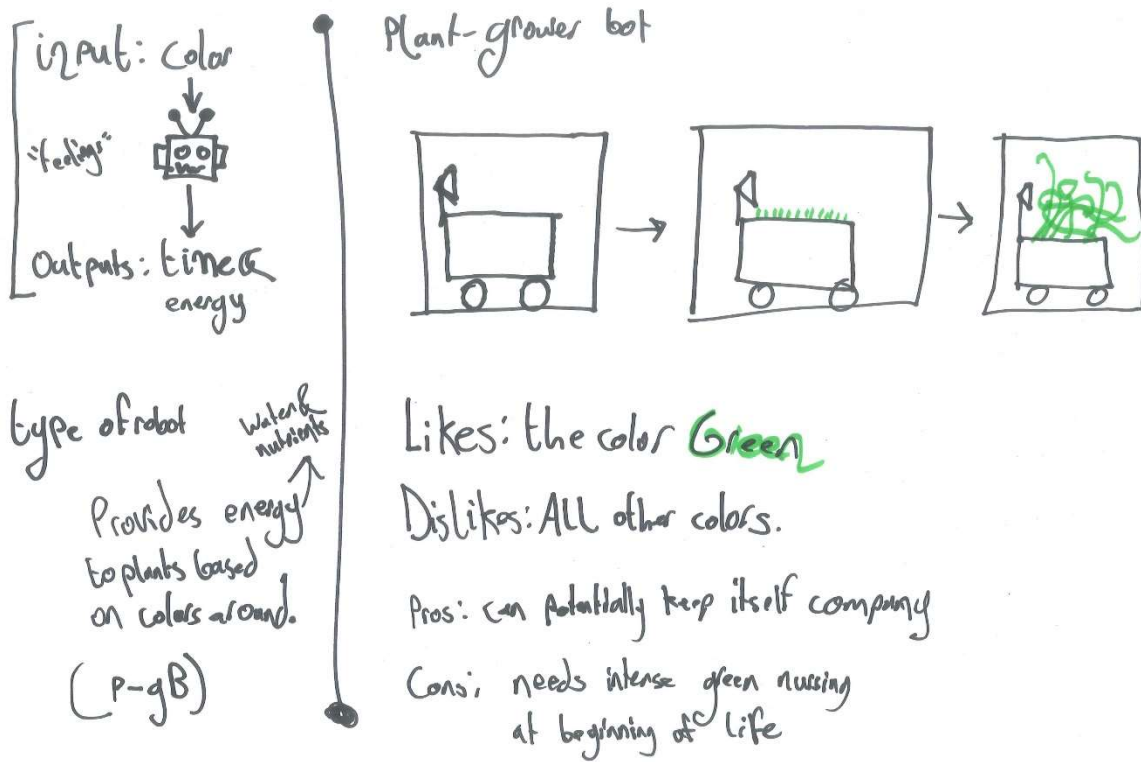


Figure.125 TVDZ's Sketches - 2

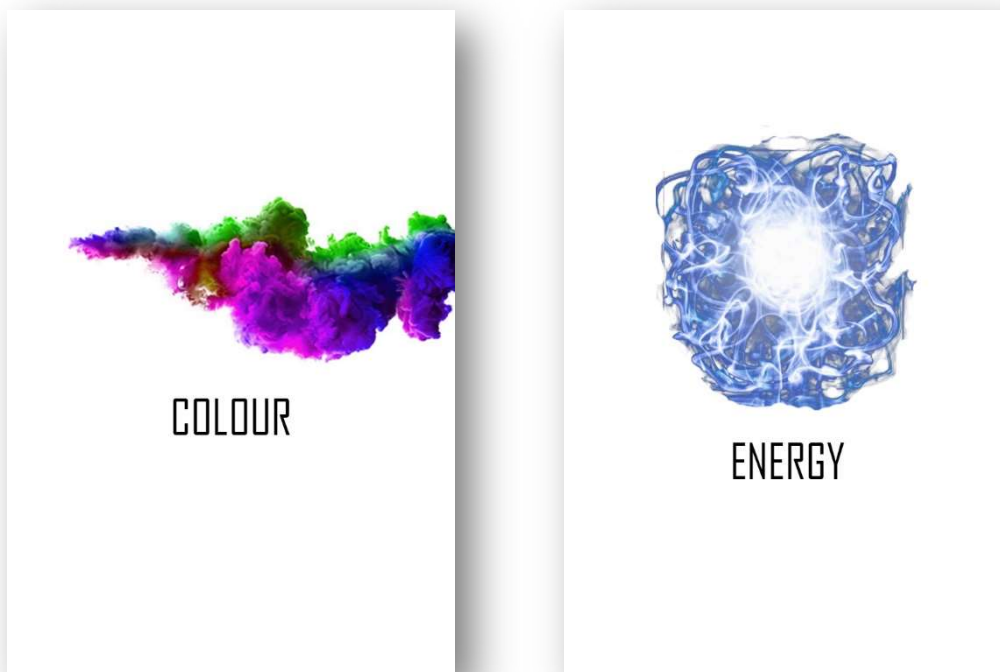


Figure.126 TVDZ's Combination: Colour to Energy (or vice versa)

Creation - 2 for Theme 4 (colour-energy):

PGB (Plant Growing Bot) (fig.125) is a robot that loves colour, just like the LTB (above). However, the PGB only likes the colour green; it dislikes all other colours. Whenever this robot is exposed to a green-coloured environment, it tries to aid growth in any plants within that environment. PGB was another strange bot with an unusual characteristic. I was rather surprised that the two cards (fig.126) were used in such a way, but it confirmed to me that we all think in different ways.

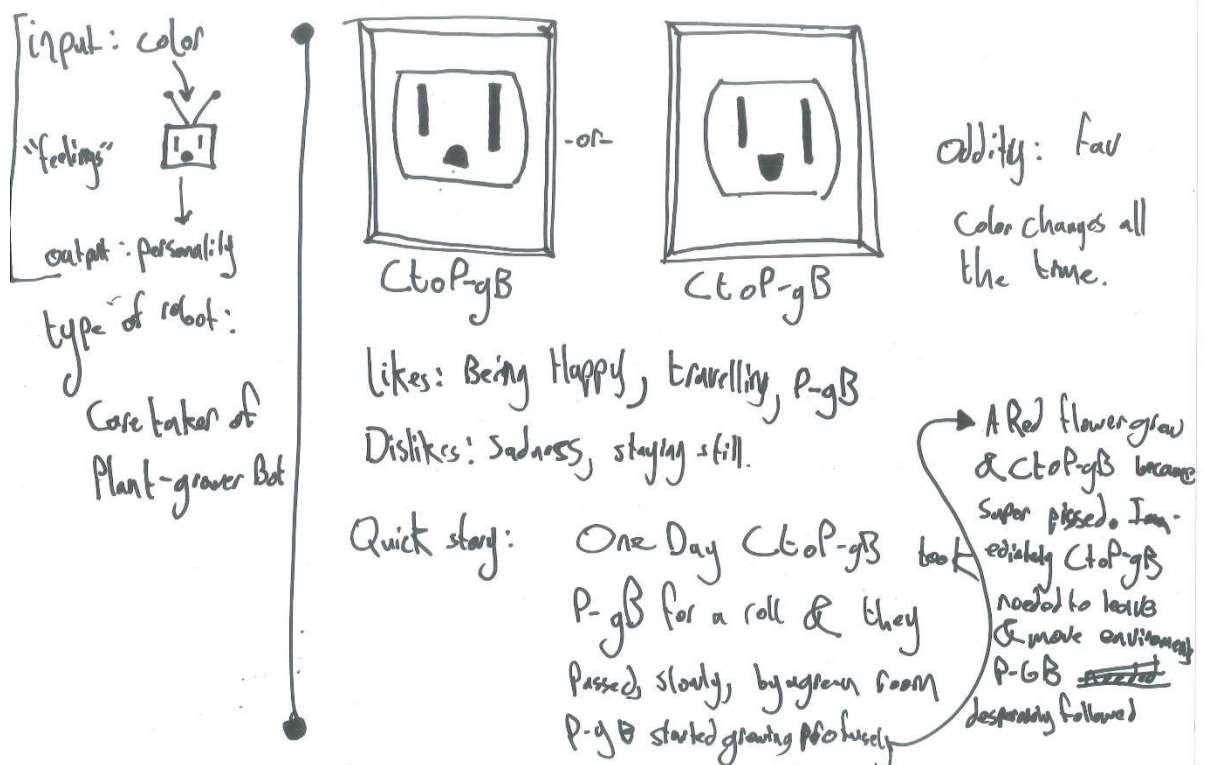


Figure.127 TVDZ's Sketches - 3

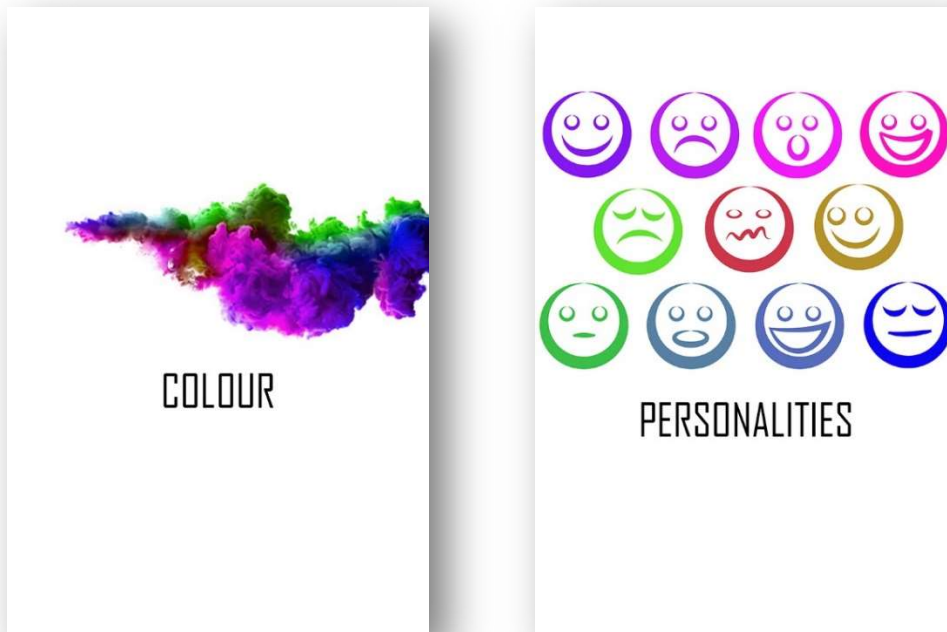


Figure.128 TVDZ's Combination: Colour to Personalities (or vice versa)

Creation – 3 for Theme 4 (colour-personalities):

CT – PGB (Caretaker of Plant-Growing Robot) (fig.127) is a bot that cares for PGB's green colour obsession (fig.128). One day, PGB and CT – PGB went out for a stroll together and entered a green environment. PGB was so excited, due to the green coloured environment, and CT – PGB understood how PGB likes this space, and he waits as PGB feeds and helps grow the nearby plants, an expression of his joy of the green coloured environment. A little while later, PGB has grown a significant number of plants, but PGB continues to nurture the nearby plants. CT – PGB finds this dangerous because one of the orange trees was about to grow oranges, and this may harm PGB, as it dislikes all colours except green. CT – PGB understands that PGB is at risk, so carefully approaches PGB and requests it to quit the growing process.

TVDZ mentioned that this rather ridiculous or unusual scenario of robot communication was inspired by his interest in the decision-making process and the translation cards. This communication scenario between the two robots was inspiring in terms of the process of assisting each other's moves.

5.3.4.2: Feedback & How Was It Useful?

I tried not to use explicit questions to induce certain answers for my research process. I briefly asked the participants about the usefulness and influences of the tools in relation to generating creative ideas. I thought this way of questioning would help them to feel more comfortable and less burdened to answer my questions than they would otherwise have felt. In other words, I wanted to create an atmosphere in which they could relax and talk meaningfully about their experiences. Below is some of the feedback that they shared during the workshop.

JT

- JT thought the translation cards (card-B) were fun to use, but the narratives did not impress him at all. He thought one of the synaesthesia stories on the front page of the narrative tool was too long to read, and that dissuaded him from investigating the other stories.
- The main reason that the translation cards (card-B) were useful for him was because they provided all kinds of different possibilities in unusual combinations that he would not conceive of normally, and these provided him with opportunities to access various creative sources flexibly. JT's explanation was similar to the explanation provided by MS, one of the participants from the first workshop at the RCA. MS thought the synesthetic cards were engaging, as he was able to think of those translative things that he normally would not consider. The only notable difference between the two was that MS used card-A, but JT used card-B.
- JT commented that interacting and combining the cards was a playful activity. He thought this card could also be useful in one of his current projects that relates to Artificial Intelligence.

- JT mentioned that he would come up with “less strange ideas” without the cards. For example, a concept such as an orgasm would not be something that he would normally consider for the idea generation process.
- Regarding the narrative tool, JT and most of the participants were not conscious of the tool’s existence.

GJ

- Unlike JT, GJ had a slightly different opinion in relation to the usefulness of the toolkit. She was more inspired by each individual card and the name of the cards. For example, the “motion card” gave her the impression of moving joints, and the pressure of air and speed, the “pain card” made her conceive of mental illness and mental shock instead of physical pain, which inspired her to bring the idea of a pain mimicry robot (fig.94). Unlike JT, she mentioned that she used the card based on her own interpretation, which resulted in her combining her own meaning instead of the direct combination usage.
- GJ thought the cards enabled her to think of playful ideas as the card allowed her to create unexpected combinations that engaged her thought process. This unexpected quality infused her ideas, and she assumed that this unexpected outcome contributed to a playful component that influences the generation of ideas. JT, during the shared feedback, agreed with this view.

JTK

- JTK used both the idea of synaesthetic translation and his own inspiration through the card tool. For example, JTK attempted to evoke his experience through one of the cards and tried to translate that experience by using another card. Both approaches of translation and the literal, figurative and semiotic usage were adapted in JTK's creation.
- JTK thought the characteristics of the created robots seemed similar to the creators' (participants) personalities, which he felt was funny for some reason. This was an answer to my question: "I think most of the generated ideas here seem to contain playful or unexpected components. How do you think about that?"
- JTK kindly suggested a new additional card for the translation tool. The card was called "wits". However, I did not consider adopting it as a part of a new card as the concept of "wits" is not very relevant to the phenomenon of synaesthesia.
- JTK recalled his memory of senseless behaviour of spending money and created a new card called "spending" while combining different cards. He answered me via email that the reason for creating this card was to solve his reckless spending. This indicates that card-B does affect people to think in relation to their own concerns, which is a useful way to stimulate the brainstorming process.

TVDZ

- The card gave TVDZ an opportunity to explore his fascination with colour perception. This interest made him pick the “colour” card for all three of his robot ideas. Other cards were randomly picked as a translative output for the “colour” card.
- Although I have deleted a few long stories from the narrative tool, based on the feedback from the first workshop, TVDZ claimed that the narratives are still too long. Especially, having a very long text without any images does not attract him at all. He mentioned that story 9 (see Appendix M) is a good example of a preferable length with an image.
- TVDZ thought the card gives an opportunity to create playful or less serious ideas as the interaction with the cards stimulates lateral thinking and opens up the creative mind. He mentioned that the card tool seems to be more useful in generating random ideas rather than finding a specific solution for problem solving.

5.3.4.3: How Does it Contribute to the Research Questions?

The second workshop at the Carnegie Mellon University contributes answers to both **[RQ1]** and **[RQ2]**.

Firstly, this workshop enabled me to find out the improved usefulness of the updated cards (card-B) and its combination method by comparing one of the participant’s experiences from the first workshop and another from the second workshop. Unlike card-A, the expanded combination and interactive feature of card-B offered better inspiration and accessibility in terms of generating creative ideas. One of the participant’s (MS) feedback from the first workshop was that card-A (fifty-one cards – fifty-one ready fixed translations) positively encouraged him to think of translative things that he would not

normally consider. JT also shared a similar comment, but in considering card-B, which has twenty cards that enable more than 350 different translations through interactive combination, card-B has more effective accessibility to provoke unexpected, surprising thoughts than card-A. This learning and knowledge contributes to **[RQ2]** *“What tools can be created to support these approaches / applications?”* in terms of introducing an improved toolkit that can support one of the synaesthetic-provocation approaches: translation.

I have learned that card-B could evoke certain participants to imagine beyond the given card kit. For example, JTK created a “spending” card to create a new type of combination for his own inspiration (fig.116). This suggests that thinking through combining different translation possibilities using card-B could encourage participants to see through other creative lenses that are helpful in conceiving creative ideas. This response certainly contributes to **[RQ1]** *“How can the characteristics / properties of synaesthesia be used / applied to stimulate creative idea generation and debate?”* in terms of stimulating the idea generation process using the synaesthetic-provocation toolkit.

Throughout examining each of their ideas, I noticed that most of the participant’s ideas seem to have certain playful components. Three participants (GJ, JT and JTK) have shared their thoughts regarding this issue, and they all seemed to agree that one of the main reasons for this was that the interactive qualities of combining cards provided lateral and unpredictable combinations, which seems to shape playful and unexpected ideas. For them, this means unexpected components somewhat associate to the idea of playfulness. By understanding this potential relationship between playful components and unexpected features through card-B, this workshop contributes answering **[RQ1]** in terms of knowing an area that may go well with the synaesthetic-provocation toolkit and approaches.

Although a participant (TVDZ) thought the narrative tool is relatively long and lacked images, I have kept the narratives because I had already deleted a few narratives throughout the first workshop. Particularly, a participant (DC) from the first workshop was highly motivated by reading all the existing narratives. Thus, I did not plan to modify anything after the second workshop, regardless of the relevant feedback. However, I have

brought a shorter story to the front page to make this story tool more accessible, and this decision was based on the feedback received from JT and TVDZ. There seem to be different ways in which designers make use of inspirational material – it seems more common for designers to use highly visual material than text passages. This contributes to **[RQ2]** in terms of refining the synaesthetic-provocation toolkit by confirming its practical accessibility.

Although many participants were not aware of the stories during the second workshop, the narrative tools were not as widely used during both the first and second workshops as the translation card tool. However, a certain participant thought the narrative tools were more useful than the cards in generating ideas in relation to accessing and understanding the phenomenon of synaesthesia (i.e. DC from the first workshop). This understanding helps to contribute to **[RQ1]** in terms of knowing the ways people use the toolkit.

By knowing the importance of the accessibility of tools through observing the usage of both card and narrative tool, I have eventually come up with a third tool: mental imagery tool (see chapter 5.2.3: Synaesthetic Mental Imagery Tool). The mental imagery tool tries to access participants' sensory information directly by allowing participants to use intuitive toolkits. The second workshop enabled me to conceive of and develop the mental imagery tool, while I was struggling at the beginning of the synaesthetic-provocation toolkit development. Therefore, this workshop contributes to answering **[RQ2]** in terms of developing a new toolkit that allows application of the property of synaesthetic mental imagery for the idea generation process.

5.3.5: Workshop: Officer Cadet RH



Figure.129 Third Workshop with Officer Cadet RH

After the second group workshop, I have learned how my three approaches of synaesthesia application can influence designers' idea generation process through my synaesthetic-provocation toolkit. However, I did not find out whether the provocation-toolkit can also affect the idea generation process for people without a design background (or people from other disciplines). While this aspect does not constitute a key aim of this PhD research, it is a necessary element as the research attempts to share the usefulness of the provocative properties of synaesthesia as tools and inspiration sources in generating creative ideas and debates.

For the third workshop, I invited one rather distinct participant to discover the values of the synaesthetic-provocation toolkit from the perspective of a person from a non-design background. The reason for organizing a workshop for a single participant is to understand better applications of the toolkit and experiences and techniques (Sanders, Brandt and Binder, 2010).

INFO OF PARTICIPANTS:

RH is a British Army Officer Cadet aspiring to join the Parachute Regiment. I met him during one of my regular trips to a swimming pool. By coincidence, he visited the swimming pool over the past year at the same time as me (7:30–9:00am) nearly every morning before his commissioning course commenced. We then became friends and learned about each other's background. In our own ways, we were both fascinated by what the other was doing.

Although RH's background is in counter-terrorism, he was absolutely fascinated by what I am doing as a design engineer³³. He was a person with an almost excessive interest in product innovation and cutting-edge technologies (e.g., AI, robots, science fictions and weapons), and we used to talk about a host of ideas pertaining to product or technological innovation after finishing our swim. This relationship between RH and me gave me the idea to invite him as a participant for a workshop. Apart from the different theme for challenge and tools, the same procedures and rules from the first and second workshop were applied in this workshop.

ADAPTED THEME:

I showed all seven themes (see chapter 5.3.2: Themes) to RH, so that he could choose a theme based on his preference. He chose theme 7 (a theme that allows participants to create their own theme) and established his own theme that related to his own concerns as a potential infantry officer. The created theme is as below.

Theme 3: You are a military weapons designer. Design any military weapon and scenario that helps a nation's military defence (NOT offence).

³³. I have introduced myself specifically as a design engineer instead of designer because I did not want him to think that I am working in the field of either fashion design or interior design. I have had many experiences of introducing myself as a designer to people from non-design backgrounds, and many people invariably think of either the field fashion or interior design. As I have felt uncomfortable with this generalized interpretation, although I understand what they are expressing, I have learned to become more specific.

USED MATERIALS:

- Tool: card-B
- Tool: narratives
- Tool: mental imagery toolkit
- Basic writing utensils (e.g. A2 papers, pens, markers)
- Introduction sheet
- Rewards after finishing the workshop: non alcoholic drinks & crisps

5.3.5.1: Ideas Discussion

Defensive capability

1. FLIR, thermographic camera or monitor for surveillance, detection, search and rescue (temperature + vision) + colour
- 1.5 Military uniform, warships that equipped with infrared signature reducing technology
- 2 weight + speed + motion (energy)
 - exo-skeleton system assisting individual soldiers to shift greater weights, move and generate (kinetic) energy, e.g. carry ^{cosmetics,} ~~larger~~ heavier loads, weapon systems over and operate of greater speed ~~in~~ over undulating terrain.
 - Increased survivability,
- 3.1 stress, pain, temperature (touch) larger
 - A wearable system, detects key changes, vital signs of individuals real time, relaying information to commanders etc. detects anomalies such as sudden trauma, (emotion, speed, energy) pain... exposure to hazardous biochemicals (radar)
 - Sudden drop, rise of core temperature (hypo, hyperthermia) so that they can be treated in timely manner. Prevent
- 3.1.1 combine with a two-way communication system, ~~or~~ automated or user activated system (vision, sound, touch) and an advanced wearable system, life-saving first response can be given when required, and remotely if the casualty is unconscious.
 - e.g. advanced first aid instructions from doctor at base, automated delivery of epinephrine, diagnosis mechanically applied pressure to help stop bleeding, address fractures, ~~hemostats~~ hemostats.
4. battlefield augmented reality system (individual, support) advanced head up display (HUD) (pilots, drivers) (synced operations)
 - displays ~~with~~ key information; objectives, ~~variable~~ weather, time, for users triple
 - can highlight items, vehicles, structures, enemy positions, casualties, speed eg. timeline with ETAs of others
 - (IED, mine) friendlies, targets: high value to low value ammo count and supplies, count-down, intuitive.
 - unarmed civilians, maps, routes etc.

technology encompasses many qualities from temp, sound, vision, time, touch, odour... can combine all innovations from 1 - 3.1. Graphemes, personalities, maps, sound ~~complex~~ advanced systems will also allow translations, assist in complex repairs, and medical attention giving highlighted, user friendly instructions, feed back.

Figure.130 RH's Idea Sketch

RH came up with a total of six different ideas. Although some ideas evolved through some of his less developed ideas, he expressed a total of six different concepts about his theme: military defence capability.

Although I requested RH to try sketching out his ideas several times, regardless of the quality of drawing, he was afraid of sketching and told me that he dislikes drawing, as he did not want to be embarrassed. He wrote all of his ideas with a pencil on a single sheet of A4 paper. He did not use any other method to replace sketching (fig.130).

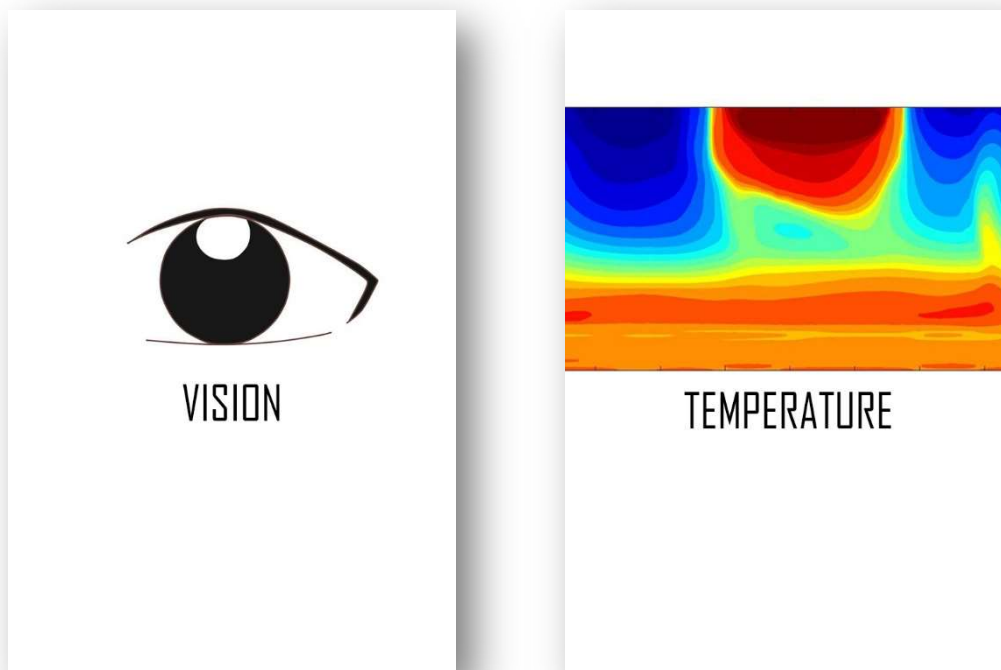


Figure.131 RH's Combination: Vision to Temperature (or vice versa)



Figure.132 RH's Mental Imagery Tool: Vision Tool

Creation – 1 for Theme 3

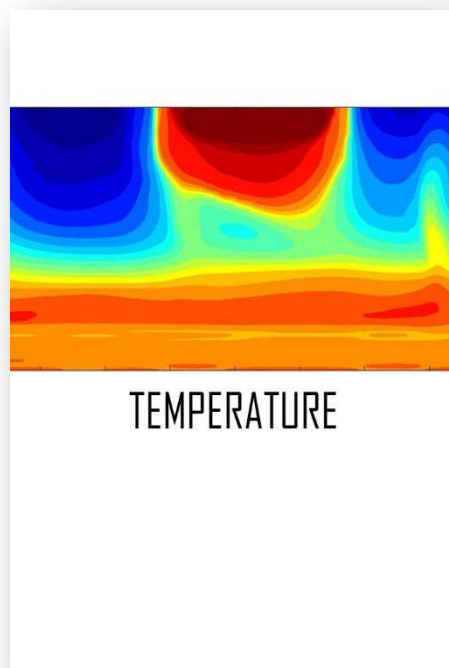
Used tool: vision and temperature cards + mental imagery prop (mirror):

By combining the vision and temperature card (fig.131) and focusing on the idea of vision through a mirror (vision mental imagery tool) (fig.132), RH proposed a very typical infrared camera that can detect suspicious things. Although he knew that the idea of an infrared camera is already widely known and in existence, RH was quite excited by this idea, as this was his first idea ever created for this workshop. This idea served as an icebreaker for his workshop.

Creation – 2 for Theme 3

Used tool: vision and temperature cards + mental imagery prop (mirror):

RH used the same mental imagery tool and combination cards to create his second idea. This innovation protects friendly naval ships from enemy detection by an infrared camera that creates an optical illusion or masking effect using water fogs to create a sphere that can manipulate vision and temperature information. I was very impressed by his imagination, though I am not sure whether this innovation is possible. The mental imagery tool (mirror) essentially inspired his imagination or idea as RH thought this mirror was blocking his view, though this tool was initially given to interact with visual information. The idea of blocking something brought him to conceive the idea of an optical barrier.



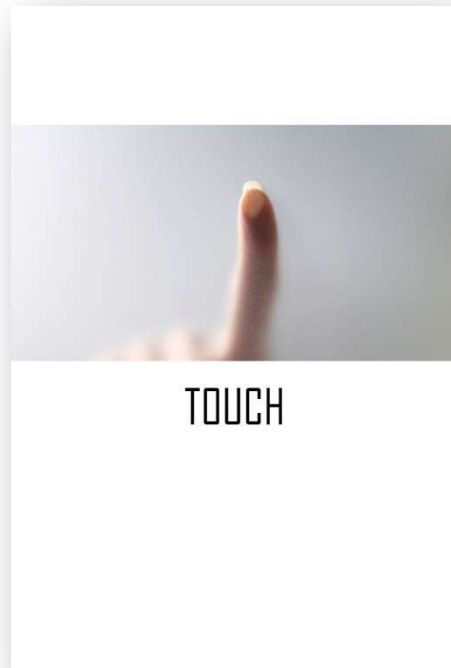
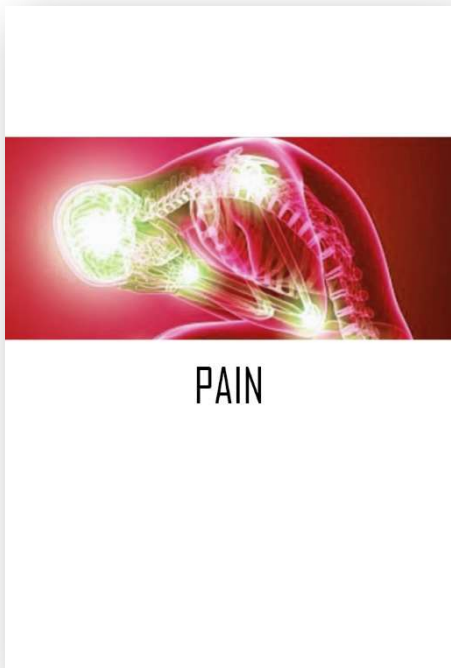
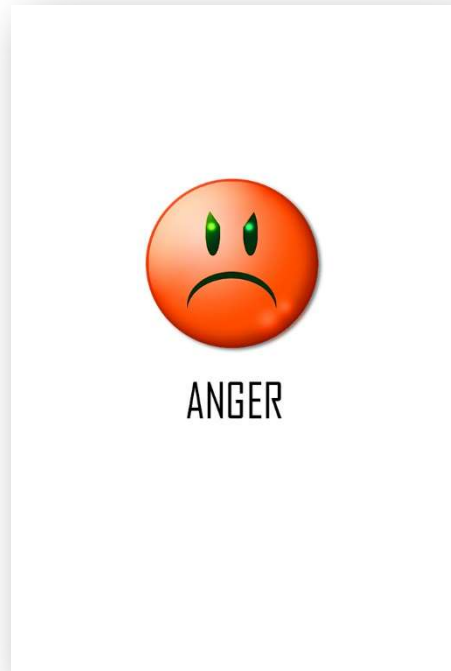
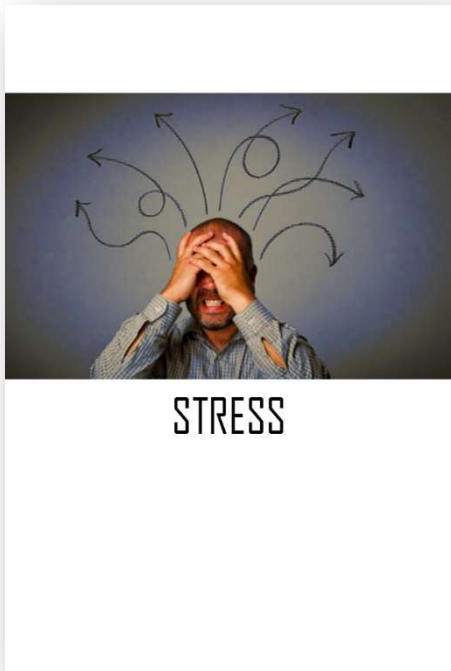


Figure.133 RH's Combination: Stress, Pain, Temperature, Touch and Anger Cards

Creation – 3 for Theme 3

Used tool: stress–pain–temperature–touch–anger

RH's third creation was an extraordinary suit for special soldiers. This suit detects soldier's status to analyse their experience, from pain to traumas, and send this information to their superiors and medical doctors for evaluation. This suit allows medical doctors to monitor and record special soldiers' status in real time and helps prevent them from critical injury (both mentally and physically).

Five cards (fig.133) inspired this idea, and each card had a task or role for the special suit. For example, the "pain" card was adopted to create this suit to detect pain (physical distress, trauma, hormonal response, etc). All the other cards were also picked for similar reasons (e.g. temperature - climatic injuries), and performed as sensors for the suits. This way of using the cards was also adopted for creation 4 (below).

Creation – 4 for Theme 3

Used tool: all the cards "except" orgasm, taste and quality

This is a far more developed suit than creation 3 and uses all the cards except three (orgasm, taste and quality). This suit offers artificial synaesthesia to special soldiers so that they can experience something far beyond their normal sensory capabilities. For example, if the enemy is hiding behind an obstacle, this suit will make the user aware, or allow them to detect, that this enemy is using vibrations or some other possible outputs. This suit will perform as an additional artificial sensory element that interplays with our bio sensory channels.

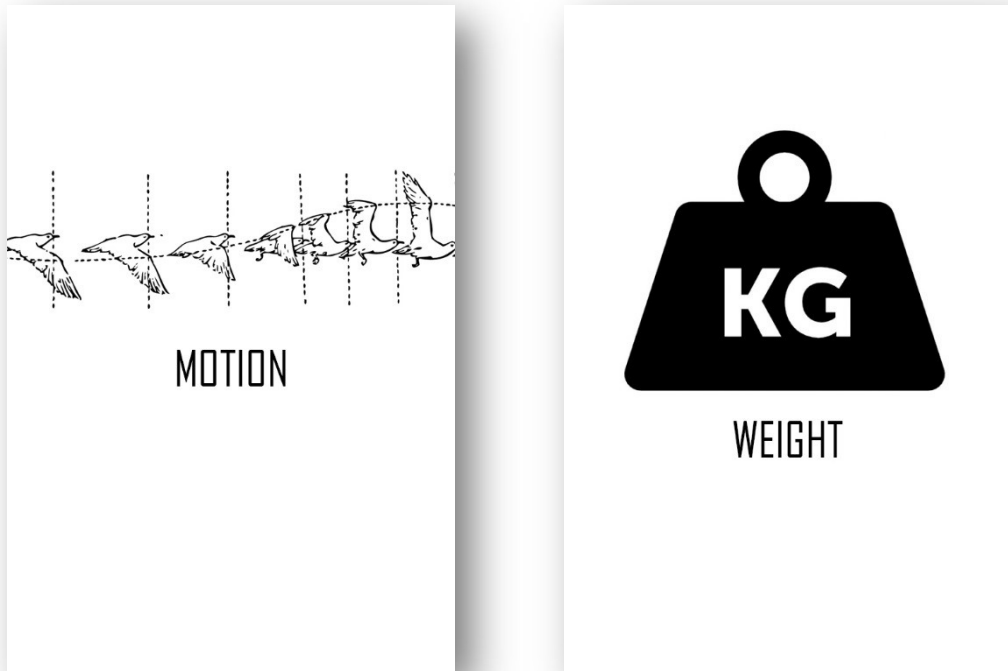


Figure.134 RH's Combination: Motion and Weight Cards

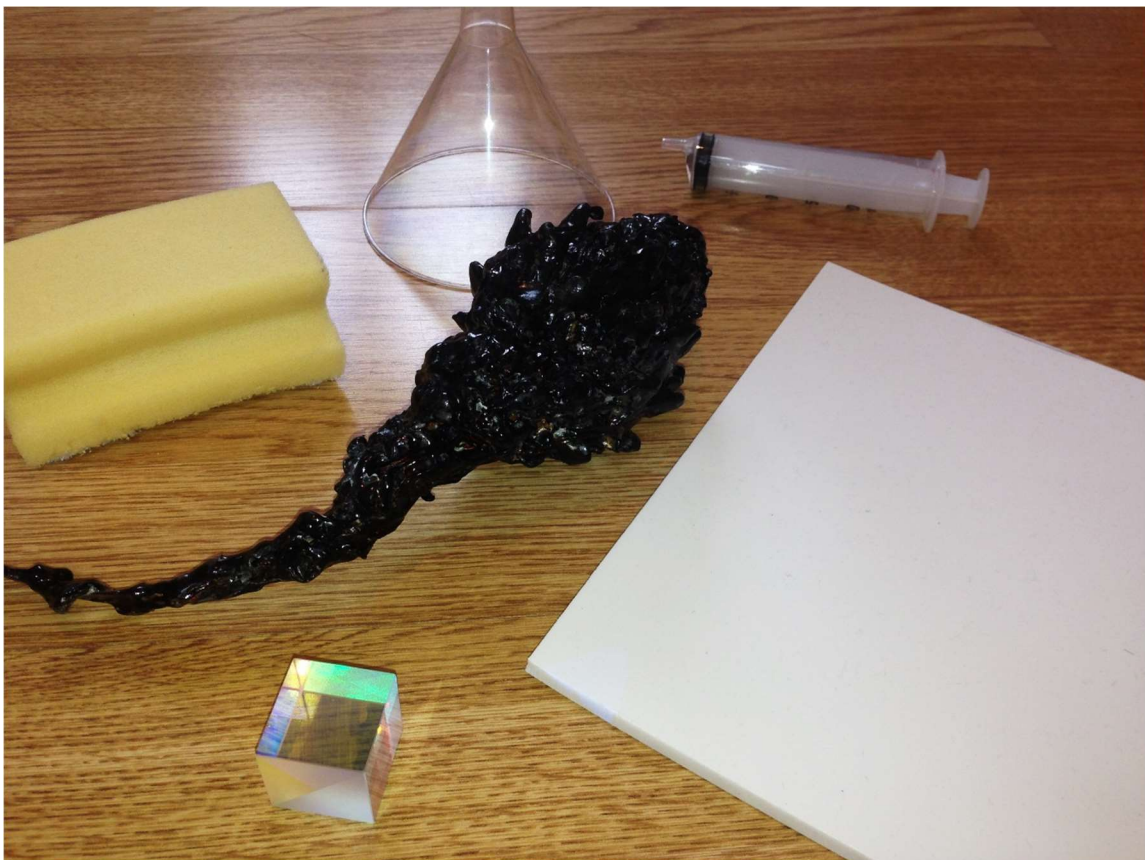


Figure.135 RH's Mental Imagery Tool: Touch Tools

Creation – 5 for Theme 3

Used tool: motion and weight cards + mental imagery props (touch)

RH came up with a very simple idea of soft blocks or obstacles that stop an unexpected vehicle-ramming attack on a pedestrian path. Each block is appropriately distanced to prevent the truck from ramming pedestrians.

When RH saw the motion card, for some reason, he immediately thought of the Nice truck-ramming terror attack in 2016. He then conceived the idea of a concrete barrier or structure through the heavy looking image on the weight card. The two cards instantly allowed RH to conceive both ideas at the same time. This concrete structure or obstacle design then becomes a soft structure, as RH thought of a force-resisting structure by engaging with the texture of one of the touch-related mental imagery props: sponge (fig.135).

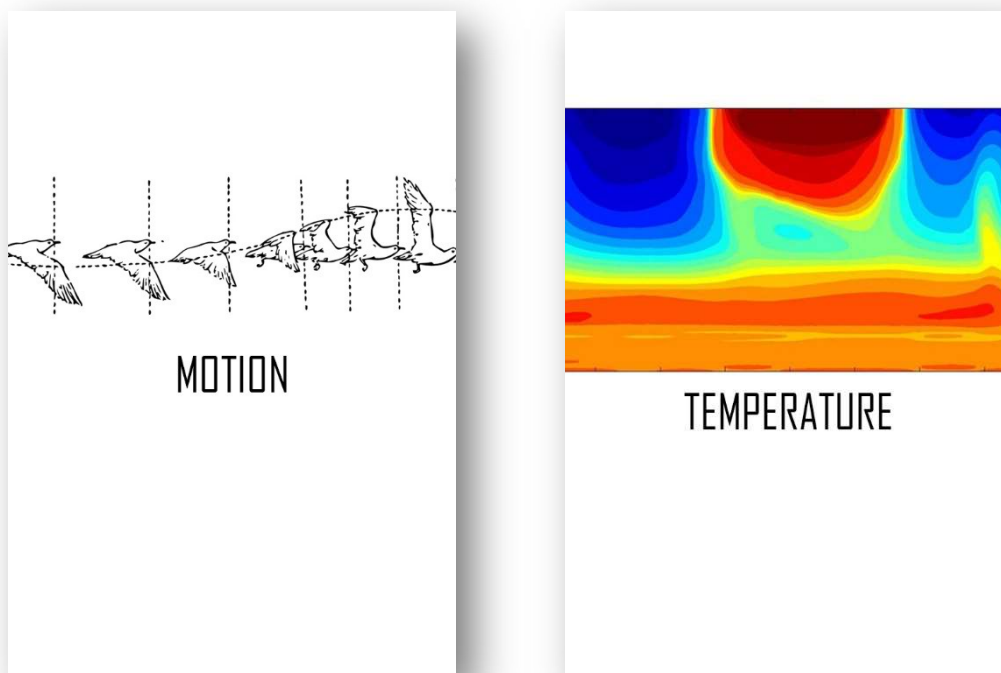


Figure.136 RH's Combination: Motion and Temperature Cards

Story 9- TL



I have always experienced sounds as having shape, weight and texture. I like to listen to music filled with thick textures and shapes that move around me. When I go to concerts I love how big shapes appear that I can dance with.

When I'm out an about, shapes can distract me, stealing my attention from what is going on in the "real" world. This is usually very exciting but can sometimes be disconcerting or even dangerous. Once, as I was riding my bike, a bus put on its breaks right next to me. The screeching sounds threw a big shape around my head causing me to have to stop in my tracks.

Some years ago I began hunting sound shapes. I capture them with a recorded and take them home where I put them in soundscapes with other shapes, which I draw and paint.

Figure.137 Narrative chosen by RH

Creation – 6 for Theme 3

Used tool: motion and sound cards + story 9

This final creation by RH was an interesting wearable device that allows soldiers to sense the approximate direction of a bullet that is coming toward them. Bullets are normally fired from a distance away from a concealed position, so it is very difficult to identify where the shot had originated. This device uses some sort of temperature pad or electric spark on the soldier's back to notify them of the bullet's direction and elevation. For example, if a bullet comes in the direction of one o'clock, this pad may create a

temperature or a weak electric spark on the back to indicate this information. For this creation, RH was inspired by the painted narrative (fig.137). He thought the black thing looked like a bullet (or death) flying somewhere, from an unknown distance, and I was very fascinated by his imagination. RH then translated the idea of a bullet to the idea of temperature. In addition, the image of a flying bird on the motion card made RH think of missiles.

5.3.5.2: Feedback & How was it Useful?

- Officer cadet RH was a highly engaging participant overall. He was completely new to this type of workshop, but worked with his ideas with full concentration, and attempted to elaborate his experience as much as possible. The first comment he made in terms of the usefulness of the synaesthetic-provocation toolkit was that he was able to imagine sensory or perception related ideas almost instantly through playing with and combining the cards; without the toolkit, he was not able to think so quickly. He then mentioned that the mental imagery tool gave him more specific outcomes than the cards. For example, his creation 2 (water fogs: optical barrier) was literally motivated by the vision-mental imagery tool, as the mirror itself reflects every light coming towards it. A similar thing happened in creation 5, where he conceived to adopt a force-resisting material from the soft sponge (one of the touch-mental imagery tools). He said that the mental imagery tools led him to a more specific inspiration, while the cards and narratives helped him envisage the bigger picture.
- RH was the first person to combine a large number of cards during the workshop. He used the cards as both an inspiration and translation for the suit (creation 3 & 4). He was more affected by the images on the cards. For example, in his creation 4 and 6, he imagined a block of concrete by looking at the image of the weight car

d and a ramming-terror attack through the motion card. RH had a similar experience when using the narrative tool (fig.137) for creation 6. While using the narrative tool, he imagined dark flying matter as a concept of death and a bullet. It seems RH was relatively more attracted by the images than the participants in the previous workshops.

- While smelling through the smell mental imagery tool, RH talked about a military weapon device called the People Sniffer, which was developed by General Electric and used during the Vietnam War. This is a device that can “sniff out” enemy soldiers in a hidden spot. This device was carried in a helicopter flying above the jungle (or in a smaller backpack version) and would indicate the location of the enemy by using a chemical reaction, produced by a concentration of human sweat or urine, on the ground below. It was referred to as an intelligence device for a short time. However, the Viet Cong discovered that this machine was being employed, so they began to put buckets of urine in the jungles to make detection difficult (Davidson, 1991, p.405). The mental imagery tools seem to influence or evoke some of his background related memories or knowledge.
- He mentioned that he would have been able to create more ideas if he had had more time. In a way, this confirms that the synaesthetic-provocation toolkit was useful in generating different ideas. This workshop applied the same duration as the first workshop (fifteen minutes of introduction, forty-five minutes of idea generations and a one-hour discussion).

5.3.5.3: How Does it Contribute to Research Questions?

The particular benefit of this workshop, unlike the previous two, was the opportunity to discover the usefulness of the synaesthetic-provocation toolkit from the perspective of a person from a non-design background. Encouragingly, this research was again able to validate the supportive elements of the toolkit in relation to generating creative ideas. The

understanding gained from this workshop was different from the first two workshops as the participants and the used tools were different in each workshop. This finding contributes an answer to **[RQ1]** *“How can the characteristics / properties of synaesthesia be used / applied to stimulate creative idea generation and debate?”* in terms of knowing the broad accessibility of the toolkit through the viewpoint of another discipline.

The new mental imagery tools were successfully used in this workshop by accessing and provoking the participant’s sensory related data for the idea generation processes. This directly contributes to **[RQ2]** *“What tools can be created to support these approaches / applications?”* in terms of sharing the ways of usage of mental imagery tools and their influence.

Initially, I did not expect that this tool could be engaging or useful for people from a non-design background. The result achieved by RH was something that I clearly never expected. Although I was aware, through discussions and books, of the creative potential of non-design professionals, I was rather skeptical, or perhaps a little biased, regarding their creative abilities and potentials. However, this workshop experience completely removed any underlying bias I had regarding people in other disciplines as non-creative.

5.3.6: Feedback & Learning From Expert: Dr. Timothy Layden

The three chapters below will cover feedback from three synaesthesia experts regarding my research. By receiving feedback from other experts, I was able to reflect on my research and concerns through third parties. Their feedback helped me to reinterpret the viability of my research within the current synaesthesia research and helped me to learn and understand new points. Three people are widely known synaesthesia experts. Thus, their feedback also contributes to validating, reinforcing and establishing my research alongside my successfully conducted workshops.

Dr. Timothy Layden is a synaesthesia research expert and practising painter within the realm of fine art. He received his PhD in Fine Arts in relation to synaesthesia from the University of Barcelona.

I had the opportunity to meet Dr. Timothy Layden in person when I visited his house to obtain some of his synaesthetic painting and sculpture and to secure some interesting workshop materials (these materials later became a part of the mental imagery toolkit). One of my plans for the meeting was not just to secure inspiring workshop materials, but to receive his input regarding my approaches to synaesthetic-provocation and the application toolkits. We had about an hour of discussion around diverse topics from Timothy's experience of sound-vision synaesthesia to his colleagues' research on the subject before I began to talk about my research topic.

Timothy shared relevant research, including the research from Michael Haverkamp with his book *Synaesthetic Design*. We had smooth discussions about Haverkamp's research, with which I am familiar, in relation to my research. Timothy agreed that much of the synaesthesia research in design tends to apply the phenomenon of synaesthesia to enhance the communication between users and products for a better sensory optimized quality of products. It mainly concerns for the finished or final quality of product for a better user experience. In this context, one of the essential comments, in terms of my research, Timothy made was that my research attempts to influence the entry level of idea incubation process instead of affecting the finalized optimized sensory quality of products. He mentioned that it is a very different perspective as I manage to apply the subject of synaesthesia as an inspirational beginning for the ideas generation process, while the other research tries to consider the phenomenon of synaesthesia to improve the outcomes of products or creative practices. This difference is quite significant as many practitioners in design have been appreciating the subject of synaesthesia to influence "output" for creative activities, but I am valuing it as "input" sources to influence different creative challenges, which share a new perspective in synaesthesia application research in a creative context.

5.3.7: Feedback & Learning From Expert: Dr. Richard Cytowic

Dr. Richard Cytowic is a neurologist and a pioneering synaesthesia researcher who re-established interest in synaesthesia during the development of neurology (Balla, 2012,

p.78). He has published a number of books related to synaesthesia including of the popular 1993 book *The Man Who Tasted Shapes*.

During my PhD research, I was very honoured to receive a request from Richard to use my works in his new book. He considered one of my early motivational projects, *Essence in Space*, as an example of artistic contrivance, a pseudo-synaesthesia-based creative approach in modern day art practice, alongside another example from the novelist Joris-Karl Huysmans's (1848–1907) taste-sound symphonies. This communication provided me with an opportunity to interview Dr. Richard Cytowic, so I can evaluate whether my research and concerns are meaningful in any way within the field of synaesthesia research.

One of the key questions I asked him was his view on research that aims to create methods or approaches of applying the provocative qualities of synaesthesia as inspirational sources for generating creative ideas. Richard commented that this research approach is fine within synaesthesia research as long as the research distinguishes between naturally-occurring developmental (perceptual) synaesthesia from deliberate contrivances, such as colored music (e.g. Scriabin and Sir Arthur Bliss), or from the mere idea of metaphoric cross-sensation. He emphasized the need to be careful not to conflate the term synaesthesia, as it means different things to different interested parties. This is an apt point because the term is understood in different ways by different people, which causes confusion as they may be talking about different things (fortunately, my research was aware of this issue from the very beginning of the research – see chapter 3.2.2: Synaesthesia Research and Boundaries). In this sense, the term synaesthesia within my research can be situated as an inspirational tool or approach that amplifies our creative dimension that was derived and discovered throughout my exploration into the experience of the phenomenon of synaesthesia.

5.3.8: Feedback & Learning From Expert: Dr. Joel Salinas

Dr. Joel Salinas is an American neurologist, writer, and researcher, and is currently an Instructor of Neurology at Harvard University as well as clinician-scientist Harvard T.H.

Chan School of Public Health and the Framingham Study at the Boston University School of Medicine. He is also a practitioner in general neurology, behavioral neurology and neuropsychiatry at the Massachusetts General Hospital in Boston, Massachusetts (Anglely, 2017; Harvard T.H Chan, 2014) ³⁴.

We met in November 2017 at the National Conference of the American Synaesthesia Association (ASA) at Harvard University, where we had both been invited to speak. After my talk, he was very excited about my research and projects, and we had a good discussion regarding the possibility of a potential collaboration. This positive relationship encouraged and allowed me the opportunity to ask him for feedback (see Appendix J: Interview Content: Dr. Joel Salinas). Apart from our verbal communications at Harvard, I have asked him three questions via email. Joel re-listened to my talk at ASA 2017 Harvard³⁵ prior to answering my questions.

By reviewing Dr. Joel Salinas's feedback, I was able to confirm that inspiration from synaesthesia can be incredibly useful in various creative processes. In his judgement, the toolkit and approaches will enable people to explore ideas and debates through various cross-sensory speculations, which will assist cognitive flexibility in developing multiple concepts and questions. These methods can also be helpful in terms of developing a more personal and compelling design experience. It inspired Joel himself, as he was also seeking for a project collaboration using the toolkit (card-B).

Apart from this feedback, he has also commented that the area of ideasthesia (briefly mentioned in chapter 3.2.2 Synaesthesia Research Boundaries) can be a useful topic to explore as well as sensory optimisation or maximisation of cognitive-ease (see chapter 3.2.6: Synaesthetic Design).

³⁴. He is also the author of 2017 book, *Mirror Touch: Notes from a Doctor Who Can Feel Your Pain* - a collection of patient case histories and his personal experience with multiple forms of synesthesia, including mirror-touch synesthesia.

³⁵. Talk at ASA Harvard 2017: https://youtu.be/LErIgs58_M4

6. DISCUSSIONS

This chapter will share an overall discussion and speculation regarding my research questions to share an additional dimension to the research. This chapter will revisit the research questions and will contemplate what we can explore and debate for future studies.

6.1: Revisiting Research Questions

6.2: Relevant Research Areas and Future Studies

6.2.1: Ideasthesia

6.2.2: Human-Computer Interaction & Information Translation

6.2.3: Developing the Synaesthetic-Provocation Toolkit and Generated Ideas

6.2.4: Self-Evaluation: What Worked? What Didn't? What Can be Improved?

6.2.5: Where Does it Situate? How the Work Could Inform Future Research? What's the Limitation?

6.1: Revisiting Research Questions

- **[RQ1]:** *How can the characteristics / properties of synaesthesia be used / applied to stimulate creative idea generation and debate?*
- **[RQ2]:** *What tools can be created to support these approaches / applications?*

This PhD research has specifically focused on answering two research questions. They are **[RQ1]** and **[RQ2]**. In order to answer **[RQ1]**, I had to create a stepping stone question: "What are some inspiring properties of synaesthesia that can be useful in design study?" (see chapter 5.1: Three Studies of Synaesthesia). While discovering the three properties

of synaesthesia via different projects, I was able to respond to **[RQ1]**, which then enabled me, by creating different tools that allow others to use the discovered properties of synaesthesia, to answer **[RQ2]**. In other words, three properties, translation, narrative and mental imagery, were discovered through the project *Three Studies of Synaesthesia*, and these properties and approaches were tested through different toolkits and participations (see chapter 5.3: Workshop & Expert Feedback).

By answering **[RQ1]** through the project *Three Studies of Synaesthesia*, I was able to demonstrate the potential usage of three properties (translation, narrative and mental imagery) of synaesthesia from a designer's perspective (see chapter 5.1). These properties were shared through artefacts via various channels (see Appendices) to receive feedback and communicate viewpoints across different disciplines and audiences. The artefacts served as boundary objects in this PhD research (see chapter 4.7: Boundary Object).

[RQ2] was then answered by creating the toolkit and various themes to support those approaches (see chapter 5.2: Synaesthetic-Provocation Toolkits). This toolkit allowed people to access and apply the three properties to their ideas generation processes (see chapter 5.3: Workshop & Expert Feedback). Throughout a number of workshops, the toolkit was also refined for better accessibility for users, although creating a 'perfect' toolkit is not a goal of this PhD.

A number of rounds of feedback from the majority of workshop participants (both design professionals and non-professional) confirmed that these approaches and the toolkit are useful in generating different creative ideas (see chapter 5.3: Workshop & Expert Feedback). The participants used the toolkit to explore their own meaning and to handle different themes or tasks. Apart from the participants' supportive feedback, three field experts have also shared their constructive thoughts, which were encouraging and optimistic (see chapter 5.3.6, 5.3.7 & 5.3.8). One of the key pieces of feedback I received came from Dr. Timothy Layden. His feedback directly contributed to this PhD research by referring to my approach as an "input method" in relation to synaesthesia application. He saw this as being in contrast to previous research in this field, which he said had used an "output method" because it had attempted to apply synaesthesia mainly to improve the

outcome of projects, product and artefacts (see chapter 5.3.6: Feedback & Learning From Expert: Dr. Timothy Layden). Consequently, this PhD research has responded to two research questions, which enabled it to generate new knowledge (see chapter 7: Conclusion).

6.2: Relevant Research Areas and Future Studies

Throughout this PhD research journey, I have communicated with different audiences and disciplines to share my research view for potential feedback and debates (see Appendices). This communication opportunity influenced me to explore various potential domains, which include data translation & physicalisation, ideasthesia, human computer interaction (HCI), playful components, creativity, neuroscience and so on. These relevant topics enriched my spectrums throughout my PhD journey.

6.2.1: Synaesthetic-Provocation? Ideasthesia?



Figure.138 Identical shapes that share the context of both number “5” and letter “S” (Nikolić, 2009)

Unlike synaesthesia where it involuntarily triggers sensation from sensory stimulus, ideasthesia is induced by semantic representations (Cordoba, Ricco and Day, 2014, pp.127-136). Studies of ideasthesia suggest that the existing view of sensory stimuli as an inducer for synaesthetic experience should expand and embrace semantic associations (Nikolić, 2009). One of the key studies within the ideasthesia research was an investigation of grapheme-colour synaesthesia. For example, when subjects were presented with a physically identical grapheme unit (fig. 138), synaesthetes were led to believe that the grapheme associated with either letter “S” or number “5”, which the associated colours depend on, was the assumed or interpreted meaning and concept of the grapheme unit (Van Leeuwen, Singer and Nikolic, 2015). This finding suggested that there must be further important semantic aspects in relation to synaesthesia inducer research, which may help in defining the phenomenon of synaesthesia and understanding our neural correlates of consciousness³⁶. One of the distinct differences between synaesthesia and ideasthesia is that synaesthesia occurs in some people, but ideasthesia is something we all have. Additionally, ideasthesia is also sometimes referred to as low-level conceptual or unconscious / subconscious synesthesia (Cordoba, 2013, p.180).

Many of my synaesthetic-provocation approaches and tools try to embrace semantic meanings for inspiration. Thus, ideasthesia can be one of the most relevant subjects that may associate to my research, which was also mentioned by Dr. Joel Salinas (See chapter 5.3.8). For example, for the sake of their ideas generation, individuals can assume the content, context and meaning of each card and mental imagery tool. Within this context, my synaesthetic-provocation approaches and toolkit could be questionable in relation to ideasthesia.

It may be acceptable to use the term ideasthesia as a synonym for the term synaesthetic-provocation. For instance, the translation approach and card tools allow people to use the semantic meaning of each card for probable translative output; the smell of a fragrance (one of the mental imagery tools) can somehow be assumed by users (e.g. RH was using

³⁶. Understanding basic of ideasthesia: <https://ed.ted.com/lessons/ideasthesia-how-do-ideas-feel-danko-nikolic>

motion cards as a flying bullet. See chapter 5.3.5: Workshop: Officer Cadet RH). Therefore, an ideasthesia toolkit may sound more accurate, but the research tries to keep the term as “synaesthetic-provocation” for a number of reasons:

1. Strictly speaking, synaesthetic-provocation is not synaesthesia. However, the term synaesthetic-provocation was derived while researching the provocative properties of synaesthesia in a design context (see sections 5.1: Three Studies of Synaesthesia & 5.2: Synaesthetic-Provocation Toolkits & Appendices). The idea of synaesthetic-provocation is about encouraging the ideation process by using different properties of synaesthesia as inspirational sources. Thus, synaesthetic-provocation embraces both a contextual understanding of synaesthesia and the semantic components of ideasthesia for creative speculation.

2. Ideasthesia research can be recognized as a part of synaesthesia research. Ideasthesia research suggests the need for further, more precise explanation within synaesthesia research in relation to inducer studies (inducer means an opponent that induces synaesthesia. Let’s say alphabet “A” induces or triggers colour red. Here, alphabet “A” is an inducer). Ideasthesia research demands extended studies related to other types of synaesthesia beyond the grapheme-colour synaesthesia (see above example of “S” and “5” regarding grapheme-colour synaesthesia).

3. The synaesthetic-provocation toolkit consists of synaesthetes’ experience. For example, the narrative tool is a text form implement that has been extracted directly from different synaesthetes’ stories. The base of the card tools was also created through different types of synaesthesia, although some subcategories were reflections from my own interpretation regarding people’s experience of synaesthesia (e.g. there are many cards that are associated to the concept of vision, such as the shape, motion and speed cards. See chapter 5.2.1.2: Card A).

6.2.2: Human-Computer Interaction & Information Translation

Human Computer Interaction (HCI) is a field of study focusing on the interaction between humans and computers. It embraces various disciplines from the field of cognitive science, social sciences to graphic design in order to improve the interactions between users and computers. Since the emergence of HCI in the 1980s via the distribution of personal computers, today the field is almost entirely devoted to studying all forms of information technology design and human interactions to develop the means for enhancing human activity and experience in relation to technology. HCI is a “science of design” that seeks to understand and support how human beings interact with and through technology (Carroll, 1997, p.62; Mortier, et al., 2016). Some parts of synaesthesia research in this PhD can be applicable within HCI research as the subject of synaesthesia largely embraces associations between the different senses, and so it is directly related to the study of human experience.

One of the base properties of synaesthesia is translation (see chapter 5.1.1: Property 1: Translation). This is a property where one experience becomes another experience. This translative property (prop 1) was listed in the List of Physical Visualizations, curated by HCI researchers Pierre Dragicevic and Yvonne Jansen, in 2016, where they chronologically listed physical visualizations and related artefacts³⁷. This relationship between physical visualization and the translative property of synaesthesia offered me an opportunity to look into the realm of information translation or experience substitution. Some of the future studies regarding the application of synaesthesia can be focused more on the possibilities of information translation, such as those found in the works by Paul Bach-Y-Rita and Dina Ricco (see chapter 3.2.6 Synaesthetic Design). Researching various possibilities within a translative context provides a potentially intriguing avenue to be explored within the context of design as the study could also be associated to the research area, such as the field of Human-Computer Interaction (example: Appendix H: ACM CHI 2017).

³⁷. Prop 1 – translation property in the List of Physical Visualizations: <http://dataphys.org/list/turning-weight-into-scale/>

6.2.3: Developing the Synaesthetic-Provocation Toolkit and Generated Ideas

Researchers who are intrigued by the potential usage of the characteristics of synaesthesia may see the synaesthetic-provocation toolkit and the various approaches as inspiring references. Thus, the synaesthetic-provocation toolkit may be developed in several ways by others, and by me. I will now share some views on the potential development of the toolkit and generated ideas in the future.

1. The synaesthetic-provocation toolkit embraces various elements from metaphors, narratives, mental imagery to translation. Whoever is researching one of those elements and wants to use the toolkit for the purpose of generating ideas can explore it in relation to their concerns. This may generate helpful feedback that may improve the toolkit. The toolkit will be distributed via my website and other relevant domains after completing this PhD study.

2. There are many inspiring ideas that are generated through the toolkit. Apart from the ramen machine (see chapter 5.3.3: Workshop: Royal College of Art), there are many thought-provoking and reasonable ideas that can be carried out for further development. I will list some of the generated ideas below and mention their potential.

- A body-attaching device for soldiers that detects or senses the direction of a bullet coming from an unknown spot is an intriguing and probable innovation (see chapter 5.3.5: Workshop: Officer Cadet RH). Although I am not a military technologist, I can easily conceive that this kind of innovation has the potential to save people's lives. RH and I have agreed to propose an article about this idea in a military magazine in the future, based on further research and development. What are the possible military innovations we can conceive through synaesthetic-provocation? This approach can be an unusual route or

avenue to investigate in the future.

- An idea from a participant was a tiny robot that sits on a table and generates a mist according to the food in front of him or her, to improve the taste and experience of foods (see chapter 5.3.4: Workshop: Carnegie Mellon University). For me, this device or robot sounded very interesting in terms of mediating or improving interaction between food and humans. In addition, I thought this type of innovative kitchen device could be used in restaurants to attract and please customers in a real-world context.

- A very light ping-pong-looking ball that creates a loud sound, like a heavy weight object, when it is dropped (see chapter 5.3.3: Workshop: Royal College of Art). This idea enables users to experience unexpected sensory interaction, which I thought was playful. Several participants from different workshops have mentioned that unexpected translation offers playful aspects. This relationship between unexpected translation and playful components could be explored further in the future.

The synaesthetic-provocation toolkit and approaches can generate various ideas and speculations. As I have mentioned in some of the examples above, these ideas can be developed in numerous, intriguing ways in relation to marketing, military research and playful things and so on. As such, the extensive possibility of the toolkit can shape different creative potentials and outcomes both within research and real-world contexts.

6.2.4: Self-Evaluation: What Worked? What Didn't? What Can be Improved?

By interacting with various participants using the synaesthetic-provocation toolkit throughout different workshops, I have learned and found a variety of usages for the toolkit that were beyond my expectations. While some parts of the toolkit did not work as

I initially planned, some worked better than I expected. I was also able to discover things that I had never considered. Below, I would like to articulate some of the things I learned through the process of self-evaluation. Some of the things I learned are based on the feedback I received (see section 5.3: Workshop & Expert Feedback).

- Card-A provided an opportunity to speculate within a fixed translation context. Although this fixed opportunity received negative comments in terms of limiting the accessibility of possible translations, some participants have commented that this fixed translation offered immediate ready-made insights for the ideation process. This was something that I did not expect or know before conducting the workshops.

- Card-B probably worked the best within the synaesthetic-provocation toolkit. It provided great accessibility and interactivity to the participants. Many of the unexpected combinations generated playful ideas. Prior to the workshops, I did not know that the unexpected translation would inspire ideas related to playfulness.

- Although the narrative tool was welcomed by a few participants, most of the participants disliked using the text-formatted tool. Most participants seemed to be inspired by visually attractive tools. There were many reasons behind this (e.g. the text was too long, time-consuming and less engaging). The less engaging aspect was something that I expected, but I still wanted to experiment with this type of tool to provoke the participants through a detailed experience of synaesthesia.

- The mental imagery toolkit was created to influence participants' thoughts by accessing sensory experience through different experiential tools. A participant successfully used this mental imagery toolkit, but it was not widely deployed in the workshops as it was created after the second workshop. This mental imagery toolkit can be further developed

with other potential experiential tools in the future. For example, the touch tool could have more varieties and the sound tool could have better accessibility.

6.2.5: Where Does it Situate? How the Work Could Inform Future Research? What's the Limitation?

Research development on the subject synaesthesia has largely been based on scientific analysis (see section 3.1: Understanding Synaesthesia). However, the research paradigm has now shifted, and synaesthesia researchers are now exploring the usefulness of synaesthesia in a wider setting. In this context, this PhD research functions as a catalyst for this new inquiry, and it is hoped that it will inspire debates on synaesthesia application in design research. A large body of synaesthesia application research in design discusses cross-sensory feedback and product experience optimisation (see section 3.2: Synaesthesia in Design). However, this doctoral research seeks to find tangible ways to use this intangible subject as inspiration, which is a completely different way of employing the subject compared to the existing synaesthesia research in design (see section 7.1: Original Contributions to Knowledge). Particularly, subjects such as provocation, creativity and ideation in relation to the topic of synaesthesia could influence the limited scope of the current synaesthesia research within the field of design (see section 3.2.2: Synaesthesia Research and Boundaries).

This research informs an issue related to ideation and synaesthesia from a designer's perspective by utilising various participant studies (see chapter 5.3: Workshop & Expert Feedback). The relationship between creativity and synaesthesia is one of the exciting subjects that synaesthesia researchers in the field of neuroscience are willing to explore (see section 3.1.6: Synaesthesia and Creativity). Thus, understanding the manner in which this doctoral research is trying to employ different properties of synaesthesia as inspiration sources for the ideation process could be meaningful when reviewing qualitative studies to determine how different aspects of synaesthesia can influence individuals' creative abilities. This qualitative study, which has progressed from participants via workshops and toolkit, may facilitate future discussions between

practitioners and researchers from both the field of design and science.

The properties of synaesthesia discovered through the pilot studies (see section 5.1: Three Studies of Synaesthesia) may also provide a number of opportunities for speculation within synaesthesia research. The three properties of synaesthesia could help people to understand better the various traits and characteristics of synaesthesia, which could contribute to the research that explores the relationship between synaesthesia and its peculiar features. Researchers who are interested in its peculiar features can also build upon beyond the three properties of synaesthesia. This qualitative study, through a number of different properties of synaesthesia, will influence the articulation and understanding of different traits of synaesthesia in the future (see also chapter 7: Conclusion).

The limitation of this doctoral research is that the studies are largely based on qualitative research, which means this research is primarily interested in exploring in-depth details of participants by trying to understand the subjective meaning they ascribe to their issues and experience (see chapter 5: Design Studies). This way of finding is problematic in terms of extending the analysis to the wider population, as the study of research is not about statistically discovering something, but, rather, trying to interpret and collect people's thoughts, ideas, meanings and experience holistically. Therefore, while this research shares the collected data and experience from the participants regarding different properties of synaesthesia, the toolkit and its potential usefulness through participatory workshops, it also shows the limitations of the qualitative approach in terms of the difficulty in generalising the findings due to the subjective nature of the research. This aspect can be one of the concerns that this research could develop and explore in the future.

7. CONCLUSION

7.1: Original Contributions to Knowledge

7.1.1: Discovering Three Properties of Synaesthesia as Inspiration Sources

7.1.2: Development of Synaesthetic-Provocation Toolkit

7.1.3: Designer's Perspective within the Realm of Synaesthesia Research

7.1: Original Contributions to Knowledge

This PhD has made three original contributions to knowledge through practice-based research.

7.1.1: Discovering Three Properties of Synaesthesia as Inspiration Sources

The literature and practice review have shown the lack of debates on synaesthesia application research within the field of design. The previous synaesthesia research and practices were largely focused on experiments regarding cross-sensory translation, and optimisation of all the senses for mass-market product innovations for the ever-improving user experience. Especially, the idea of synaesthesia³⁸ was mainly utilized or applied to enhance or share a certain sensory quality for products or projects. This means synaesthesia-related projects usually embraced synaesthesia-relevant information to mimic or exemplify the phenomenon of synaesthesia (my project *Essence in Space* can be one of many such examples), which I consider to be an “output” method of considering synaesthesia application. However, this PhD research tried to consider the phenomenon

³⁸. Throughout exchanging email correspondence with Dr. Richard Cytowic, he has mentioned the meaning of the “idea of synaesthesia” as an artistic contrivance, a pseudo-synaesthesia-based creative approach in creative art and design practices, which is different from the phenomenon of synaesthesia. Indeed, he agrees that this is also part of synaesthesia research but in a different context.

of synaesthesia as potential inspiration source that can stimulate creative debate and the ideas generation process. This research specifically applies the phenomenon of synaesthesia as inspirational source using discovered approaches and a toolkit for the idea generation process, which is a new perspective and interpretation within synaesthesia research in relation to the field of design. I consider this approach as an “input” method of synaesthesia application (see chapter 5.3.6: Expert Feedback: Dr. Timothy Layden). While the previous “output” application method tried to influence and shape the external value of things to communicate with external audiences, the “input” application method attempts to evoke and encourage thoughts to facilitate dialogue with one’s internal world or inner audience, which I argue is a distinctive, new knowledge contribution arising from PhD research.

This novel finding and achievement was principally enabled by discovering different properties and approaches of synaesthesia through the project *Three Studies of Synaesthesia*. By creating, demonstrating and debating with various audiences throughout the project, this PhD research has discovered three provocative properties of synaesthesia that can be used as creative approaches. Comparing the previous synaesthesia application research to my findings through reviewing creative practices and literature, this process of discovering three properties and approaches of synaesthesia through a design practice is a new type of exploratory approach. This exploratory process of discovering creative implementation can also be one of the minor new types of knowledge that I have recognised throughout this PhD research. These new properties and creative approaches later enabled this research to conceive the synaesthetic-provocation toolkit, which allows people to practically use the intangible properties of synaesthesia to encourage the ideas generation processes. Three properties that I have found were translation, narratives and mental imagery.

- Synaesthetic translation: This is a property or characteristic of synaesthesia that translates one experience or data to another form (either tangible or intangible).
- Synaesthetic narrative: This is a property that the phenomenon of synaesthesia always

contains, regardless of its type from various individuals.

- Synaesthetic mental imagery: This is a property that expresses the distance between our mental sphere and the reality of the world.

How can people practically use these properties and approaches for their idea generation process? Without discovering these properties and approaches, this PhD research was not able to develop the synaesthetic-provocation toolkit. The process of discovering the properties was the answer for the **[RQ1]** *“How can the characteristics / properties of synaesthesia be used / applied to stimulate creative idea generation and debate?”* that became a key for answering **[RQ2]** *“What tools can be created to support these approaches / applications?”*

7.1.2: Development of Synaesthetic-Provocation Toolkit

The synaesthetic-provocation toolkit was developed and inspired by the three properties of synaesthesia. It was made to allow people to practically adapt and use discovered properties of synaesthesia as a creative approach to facilitate creative debates and ideas. The toolkit has been developed and refined throughout the workshops by utilising participants' feedback to improve the effectiveness of the toolkit. The synaesthetic-provocation toolkit contains various tools. They are synaesthetic translation cards, narrative tools and mental imagery toolkits. Each tool allows people to access and reflect different properties of synaesthesia – translation, narrative and mental imagery – for their inspirations.

- Synaesthetic translation cards-A & -B: These cards allow users to think through the translative or transformative properties of synaesthesia as inspirations.

- Synaesthetic narratives tool: the narrative tools allow users to discover inspirations through reading and understanding different experiences of synaesthesia.

- Synaesthetic mental imagery toolkit: This toolkit influences our process of thinking by intuitively accessing our basic sensory information (taste, sight, touch, smell, and hearing).

Seven themes or tasks were also developed to be applied in the workshops to understand the validity and reliability of the toolkit. The themes embrace various topics from designing toys to creating robotics. By applying these various themes, this research was able to find out the influences of the toolkit from different contexts; it could learn how and why they can be useful as inspirations (see chapter 5.3: Workshop & Expert Feedback). The synaesthetic-provocation toolkit and the themes were employed specifically to understand the usefulness of the discovered abstract properties of synaesthesia. Thus, the toolkit can be seen as another element of new knowledge developed through this PhD research, as it provided practical solutions of adapting those intangible, abstract properties of synaesthesia.

7.1.3: Designer's Perspective within the Realm of Synaesthesia Research

Although the interdisciplinary nature of synaesthesia research does include the perspective of both science and art, large bodies of research share the scientific analysis of synaesthesia to define and understand it better as a phenomenon. Throughout the past several years of this PhD research, one thing that came as surprise was that there was comparatively little in the way of design literature covering the subject synaesthesia when compared to the large amount of synaesthesia-relevant design practices or projects. Although there is much synaesthesia-related literature discussing the topics of ergonomics, multisensory, art practice, music and so on, the topic was not widely creating palpable discourses within the field of design research (see chapter 3.2.6: Synaesthetic Design). However, recently, a new enquiry has emerged from the field of science to discover the potential usefulness of synaesthesia applications beyond the mere scientific analysis (see chapter 3.1: Understanding Synaesthesia). This means, to put it another way,

this research can meaningfully influence and facilitate the current paradigm of synaesthesia research by sharing various creative insights and innovative thinking through the idea of synaesthetic-provocation and experiential toolkits. Therefore, this research can become a catalyst for responding to this new inquiry from a designer's point of view, which I believe can be valued as new knowledge and understanding.

APPENDICES

The appendices briefly introduce various activities in which I participated, organized, published or conducted an interview throughout this PhD journey.

Appendix A: The Lab Project

25 & 26 July 2015

→ step #1: The Symposium

A playful take on the format of an academic conference, this two day event will gather scientists, curators, creative practitioners and members of the public to discuss the possible entanglements between art and science through the subject of multisensory interactions.

Saturday 25 July
Kingsgate Project Space

11.15 - 12.15pm
Introductory Session:
Multisensory Perception and
Synaesthesia

Speakers: Dr Michael Banissy and Chang Hee Lee

12.30 - 2pm
Discussion Panel 1:
The Science and Culture of
Sensing Sound

Speakers: Christina Kazakou, Dr Ana Tajadura-Jimenez and Dr Maria Chait

3 - 4.30pm
Discussion Panel 2:
Body, Vision and New Technology

Speakers: Madi Boyd, Rachel Bedder, Giles Askham and Professor Kate Jeffery

4.30 - 5pm
Being Slime Mould: modelling
sensory environmental responses
[an illustrated experiment]

Speaker: Heather Barnett

Sunday 26 July
Kingsgate Project Space

2, 3 & 4pm
Movement Workshop

Join movement directors Katie Grube and Nicola London in a movement workshop to connect to your proprioceptive senses and a more "embodied" cognition. Sessions will last ± 20min.

All events are free of charge. Booking is not required but recommended. More information on how to book can be found on the website.

27 July - 13 August 2015
→ step #2: The Experiments

During the second phase, Kingsgate Project Space will be transformed into a studio space where artists can conduct their experiments.

Participating artists: Rose Pickles, Vivienne Du, Yiyun Kang & Yen-Ting Cho

14 - 21 August 2015
→ step #3: The Final Exhibition

This experimental project will culminate in a week-long exhibition. Breaking the rules of the traditional gallery space, visitors will be invited to take part in a fully interactive experience.

Exhibition Opening: 14 August 2015, 6-8pm



The Lab Project
25 July - 21 August 2015
thelabproject.tumblr.com

Supported by:

Camden
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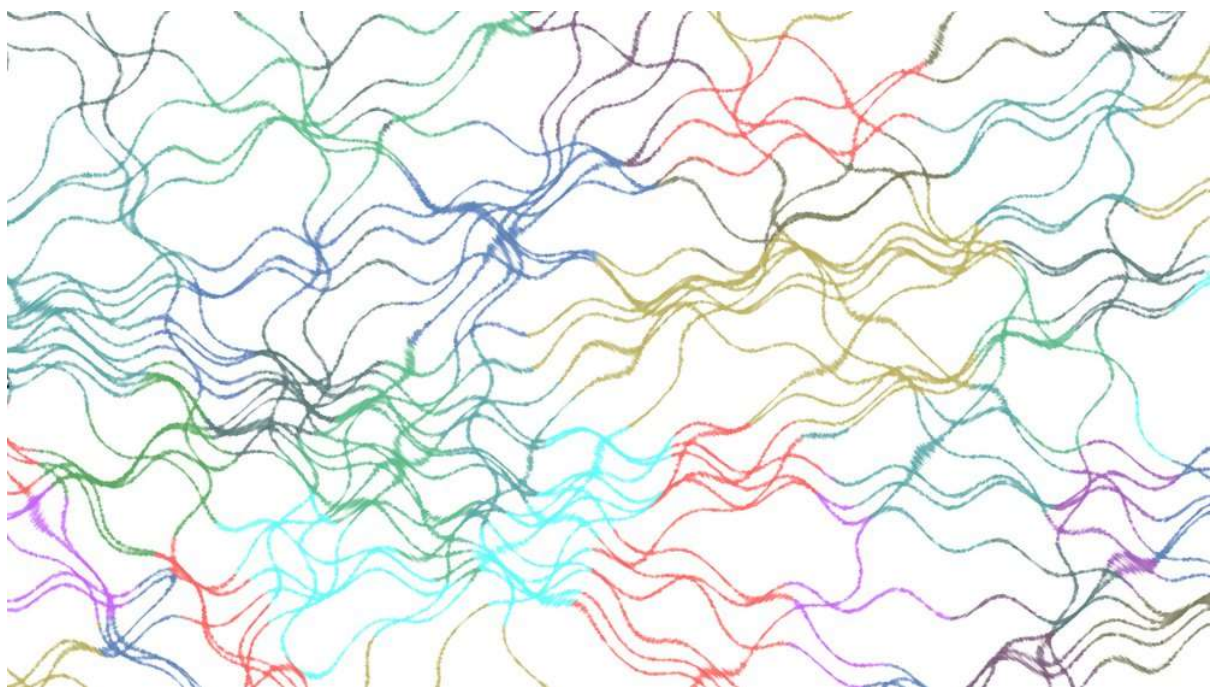
Kingsgate
Workshops

Kingsgate Project Space, 110-116 Kingsgate High Street, NW6 2JG London
Join us online: www.facebook.com/thelabproject15 | @TheLabProject15, #labproject

The Lab Project: Symposium Steps

In May 2015, I was invited as one of the keynote speakers to a symposium called The Lab Project, which was organized by the Camden Arts Centre and Kingsgate Workshops Trust. The symposium format was that of an academic conference and ran for two days; various groups of people including scientists, curators, creative practitioners and members of the public discussed potential intersections between art and science via the subject of sensory experience ³⁹. This symposium was my first platform to be able to share my research to a wider public, which included well-known researchers in their fields such as Dr Michael Banissy, Dr Eleni Ikoniadou, Dr Maria Chait, Dr Ana Tajadura-Jimenez, Professor Kate Jeffery and Professor Heather Barnett. This talk gave me a general impression of lack of discourses, research and debates between design and synaesthesia application.

Appendix B: Crossing Over: The Art & Science of Multisensory Perception



Poster Graphic for the symposium: Crossing Over: The Art & Science of Multisensory Perception

³⁹. Symposium link: <https://www.camdenartscentre.org/whats-on/view/testbed-15>

In July 2016, Paris Salinas, a fellow research associate, and I co-organized a joint symposium and exhibition between the Royal College of Art (Innovation Design Engineering and Design Product) and the University of Oxford (Crossmodal Research Laboratory). The symposium was called Crossing Over: The Art & Science of Multisensory Perception, and I wanted to gain different views from the field of science regarding my research. This interdisciplinary symposium was also one of the experiences that broadened the spectrum of my research. Three doctoral researchers from each institution crossed over to a different discipline to discuss the following keywords during this symposium ⁴⁰.

KEYWORDS: synaesthesia, design provocation, sensory manipulation, multi-sensory integrations, food and flavor, vision and taste, sensory experiments, experimental psychology, cognitive neuroscience, cross-modal research

SPEAKERS:

11:00 – 11:10am: Bruna Petreca (RCA)

Welcoming

11.10–11.30am: Paris Selinas (RCA)

The food industry has developed sophisticated tools and methods to measure the mechanical properties of food. However, the tasting experience is an affective, multisensory phenomenon that goes beyond the composition of ingredients. This presentation will explore how different ways of human expression (verbal language, visual representations & embodiment) can – or, in cases, cannot, enable people to articulate their tasting experiences. This work lies on the intersection of Human – Computer

⁴⁰ · Symposium link: <https://www.rca.ac.uk/news-and-events/events/crossing-over-art-science-multisensory-perception/>

Interaction, Food Design and Open Design. Implications and opportunities for these three areas will be discussed.

11.30–11.50am: Chang Hee Lee (RCA)

This presentation considers that the extensive inputs of synesthesia have exceptional potentials that are capable of conceiving exciting design provocations. The presentation will cover how the intriguing properties of synesthesia can contribute to and encourage design outputs within the context of design. The presentation will mainly discuss three different properties of synaesthesia (translation, narrative and mental imagery) and will explore how they can potentially be applied in creative practices.

11.50am–12.50pm: Alejandro Salgado Montejo (Oxford), Clea Dese Brock (Oxford), Mathew Tompkins (Oxford)

How stable is our perception? Is perception the same as reality? Can we hack perception to alter reality? We have created a sensory story that involves vision, taste, touch, and sound, in order to discuss how our sensory experience greatly defines who we are, what we think, and what we believe. We have cooked up a series of demonstrations designed to invite you to explore your sensory experience and challenge you to rethink the senses. First Matt Tompkins will talk about vision and sensory illusions and how we can manipulate attention to create surprise and hack our visual experience. Afterwards Alejandro Salgado-Montejo will talk about the body as a mediator of vision-taste associations and their implications in everyday experiences and expectations. Finally Clea Desebrock will discuss how sound can mediate many of our everyday experiences and how we can tailor sonic messages to hack vision and taste.

12.50–1pm: Q&A

Round table discussion, chaired by Bruna Petreca

1–1.30pm: Exhibition

Appendix C: Film Night: Like Water for Chocolate

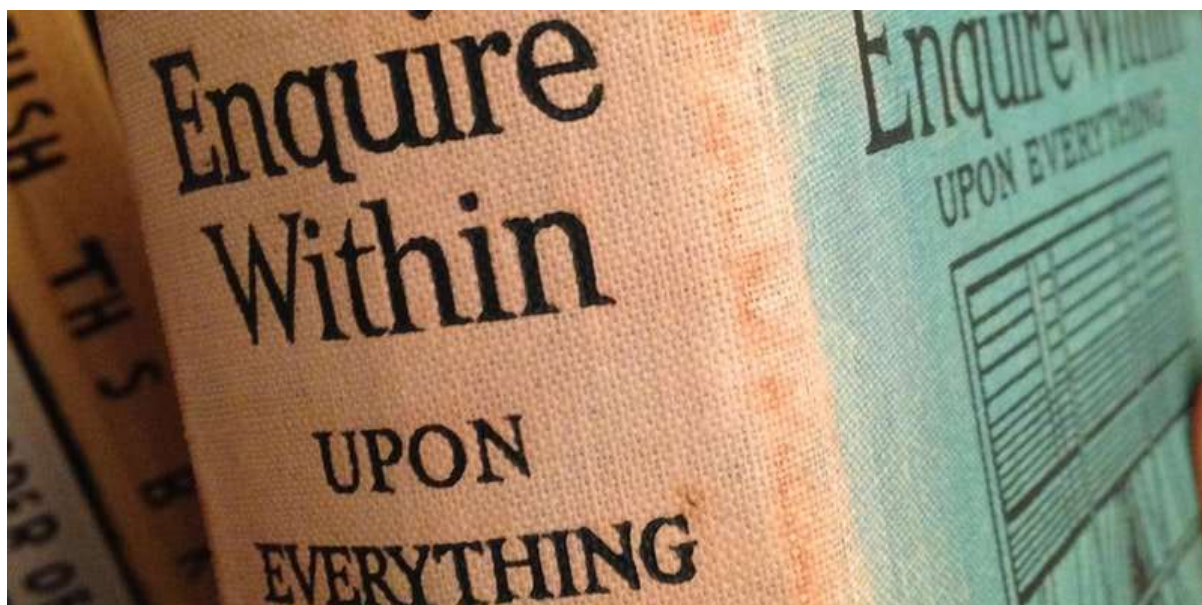


Attending the Film Night at the University College of London (UCL)

In August 2016, Doing It Together Science (DITO)⁴¹ invited me as a guest speaker for a film night, *Like the Water for Chocolate*. The film was based on a popular novel published in 1989 by Mexican novelist and screenwriter Laura Esquivel. The film portrays the Mexican Revolution of the early twentieth century and features the importance of the kitchen and food in the life of the female protagonist. The film contained magical remedies, traditional Mexican recipes and love stories. I attended to share my thoughts about this film in relation to synaesthesia research to facilitate discussions, after people had finished watching the film. By encouraging different public debates, I was able to discover their views on the topic of synaesthesia in general.

⁴¹. Doing It Together Science (DITO): DITOs is organizing many innovative events across Europe focusing on the active involvement of citizens in Citizen Science. Info: <http://www.togetherscience.eu>

Appendix D: Science has no Borders



Science has no Border event image

In October 2016, I participated with the Waag Society, MediaLab Prado and Bioscope in DITO's workstations and shared my research for public engagement ⁴². This talk and exhibition have subsequently contributed to some parts of my research, especially in terms of learning other people's (e.g., children and their parents) views on my research and project.

Description of the event:

Interested in ways to improve our environment, understand technology better, demystify medical research? Then join us for an evening of hands-on exploration and inspiring conversations! You'll not only get a feel for the kind of events, opportunities, and people involved in such endeavours, but you'll also take part in shaping the development of upcoming activities.

We will start the evening with a series of short, inspiring talks and brief introduction to our project and members of the community. We will then open the evening so you can roll-up your sleeves and join several hands-on 'workstations' in our interactive exhibition

⁴². Science has no Border info: <https://www.eventbrite.com/e/science-has-no-borders-unwrapped-tickets-27375588121>

Touch|Play|Learn showcasing activities that we have ongoing including:

- The Public Laboratory for Open Technology and Science workstation with DIY kits for environmental monitoring (e.g DIY aerial mapping, spectrometry, near infrared photography)
- The DITOs workstations with kits from our partners incl. the Waag Society, the Centre for Interdisciplinary Research (CRI), MediaLab Prado, and BIOSCOPE (e.g. DIY PCR machine, DIYBio starter kits, etc.)
- The Kesnikova Institute workstation showcasing DIY kits incl. DIY microscope & sound-activated badges
- Sensory experience workstation hosted by researchers at Royal College of Art
- The Ignite Futures! workstation to touch, play, and learn with their science busking trunk!
- ..or try our sandboxes: Arduino & BBC micro:bit kits and Squishy Circuits playground and much more!

This event is aimed at inspiring ideas and getting interests connected. We want to know what science questions, topics, or community issues you would be like to explore or work towards addressing. Your topics will form a part of our discussion table - they will be explored, linked to other efforts, and will help spawn new events.

Doors open 18:15. Children aged 0-100+ welcome! This event is wheelchair accessible.

What: Unwrapping Science has no Borders! 2 short inspirational presentations, hands-on DIY science workstations, food, tea/coffee, and biscuits [food allergies? let us know in advance!]

Where: University College London, Chadwick Building - G04 - [map] enter UCL via Gower St, turn right and follow the ShnB (Science has no Borders) signs

When: Monday, Sept 26th, 2016 18:30

Why: Because we love to explore and learn!

Spread the word! *There will be event signage directing you to the room.*

Appendix E: LRF Grand Challenge Project



Lloyds Register Foundation (LRF) Safety Grand Challenge Project

Between late August 2016 and March 2017, I had the opportunity to work as a tutor alongside Professor Ashley Hall, Dr. Laura Ferrarello, Robert Pulley, Matthew White and Mike Kann at the Royal College of Art for a project called Lloyds Register Foundation (LRF) Safety Grand Challenge. The project aimed to create potential solutions and a range of innovations to increase safety across Thames River, one of which concerned the safety of pilots' ladder transfer between vessels. The project investigated the relationship between pilots and ships as well as safety issues around water to discover both the existing and

hidden risks for practically applicable and distributable innovation ⁴³. In this project, I had several roles including weekly tutorials for student projects, building electronics, creating films, arranging interviews, help running the workshops and so on. This comprehensive teaching experience later influenced my thinking about how best to run workshops for my PhD study. My decision to adopt a card type tool as part of the synaesthetic-provocation toolkit was also influenced to some degree by the Grand Challenge project.

Appendix F: Open Senses Festival



Open Senses Festival

⁴³. LRF Grand Challenge info: <https://www.rca.ac.uk/news-and-events/press-releases/royal-college-art-tackles-dangers-ship-boarding/>

In May 2017, I was invited by one of the members from Open Senses Festival to take a part as an exhibitor and symposium contributor. There were many well-known scientists and academics supporting the festival, including Barry C. Smith (Director of the Institute of Philosophy at the Institute of Advanced Studies at University of London), Charles Spence (Head of the Crossmodal Research Group, University of Oxford), Zoe Laughlin (Director of UCL Institute of Making), and their presence was a major factor in my decision to participate. My participation led me to exhibit one of my projects *Three Studies of Synaesthesia* at the Rebecca Hossack Gallery and enabled me to interact with different audiences, including the clinician and neuroscientist Dr. Rozelle Kane, who has a special interest in novel foods, preventative health strategies and wellness.

Brief description about Open Senses Festival ⁴⁴:

Open Senses is a weekend festival of art exhibitions, live events and performances, sensory journeys and walks, open studios and labs, and a ground-breaking symposium. It has taken a small team of volunteers over two years to plan this festival and we're incredibly proud of the programme.

We chose London as the city to launch Open Senses because it is a world-leading centre of excellence in sensory practice. We are inviting all Londoners, as well as each and every tourist and visitor, to freely come and open your senses; to awaken your nose, tastebuds, and skin to the world; to notice and savour the natural, physical environment around you.

Open Senses will showcase sensory practice as a powerful tool to evoke true human emotion and create warm, lasting memories. This is a festival for every woman, man and child to hear, see, feel, taste and experience.

⁴⁴. Open Senses Festival info: <http://opensenses.squarespace.com/overview>

Appendix G: Research Through Design 2017 (RTD 2017)



Research Through Design 2017 (RTD 2017)

In 2017, I have submitted a paper about my project *Three Studies of Synaesthesia* to the Research Through Design (RTD) conference to share my exploratory process of establishing a project. RTD is a biennial conference, founded in 2013, that offers new experiential insights about what it means to practice, disseminate, and understand design-led inquiry within academic communities and beyond⁴⁵. My paper did not get accepted by the committee, but received some useful feedback through meta review. This rejection and review by the committee helped me to think about an explicit aim for the purpose of the project *Three Studies of Synaesthesia*. This review and feedback was then applied in my PhD thesis, which helped to situate and frame the project better within the PhD thesis. RTD 2017 was the first academic paper submission that I had attempted, and it enabled me to experience a broad aspect of academia in general.

Paper review:

Title: Synaesthesia Materialisation: Three Studies of Synaesthesia

⁴⁵ · Research Through Design 2017 (RTD 2017) info: <https://researchthroughdesign.org/rtd2017-website/>

Decision follow reviews and PC meeting:

Not accepted for RTD 2017

Meta-review:

Based on the discussion at the Stage 2 PC meeting and the reviewers' comments, we are unable to recommend that this submission be invited to the next stage.

This submission is overall clearly described and presented and there is potential for the work to raise interesting questions around materiality and multimodality. While there was enthusiasm for the work, the reviewers have highlighted challenges with the aims for the work and the contribution to research through design.

In the Stage 1 reviews, suggestions to explain the intentions and means of engagement for the three props or artefacts would have helped to situate the work within RTD. However, the full submission does not fully consider the impact of the designed artefacts in terms of changing or enhancing understanding of the phenomenon from the point of view of the designer (or anyone else), and as R2 indicates, the contribution to research through design is therefore limited. R1 raises questions about the aims, which, if clarified and stated explicitly, would help to frame the rest of the paper and provide direction for future analysis. Additionally, providing an explanation of why certain design choices were made in terms of aesthetic, material or interaction terms and relating these to the aims of the work would have helped to strengthen the submission. Whilst the raising of questions is valuable, the lack of analysis and reflection on the props is missing, perhaps as the work is at a relatively early stage.

Because of these questions we were unable to recommend inviting the submission for publication and presentation at RTD 2017. However, we hope this work continues to

develop well and look forward to seeing it in other venues sooner than later.

Review 1

Rating:

I would argue that this submission be accepted to RTD 2017

Review:

This project sees that design can act as a platform for the symbolic expression of synaesthete's experiences. There is a core view that the accounts of synaesthesia can be taken as starting points for the activation of 'creative practice', wherein various approaches can be taken to translate testimony into prototypes that others can then experience. The paper documents three such material expressions of synaesthesia, where each prototype takes a different approach. This is an interesting and well structured paper with scope for development.

Suggestions-content:

I would say that these three devices are different cases that share a common method, which is the materialisation of case detail, rather than constituting three methods. There is some interesting description regarding the features of the prototypes and the intention of the makers. However, beyond some interesting ideas about sharing private experiences, there is scope to refine the ambition of the prototypes, so as to be more explicit about their purpose. Is the core aim for others to derive an experience of synaesthesia, or to provide a framework for empathy? Is this a case study for the public engagement of scientific research? Or is the case an opportunity for shared activity that drives reflection on the features of interdisciplinary practices?

Being bolder about the aim of the practice will then allow the authors to make two further moves. The first would be to develop the literature on which they initially draw, which is currently a mix of historical and clinical information, so that along with the background of their topic the context that supports their mode of practice is supported (i.e. related cases of design). Secondly, explicit aims would anticipate and motivate the framework through which the work is then encountered (the production and refinement of the event), and also the forms of documentation and the types of accounts that are made of those encounters (data and analysis). For example, an ambition to provide empathy would see encounters with the 3 props staged, documented and discussed differently than if the aim was to engage participants with the detail of clinical research. There is some light discussion of observed use in the second case, so this can be seen as a starting point.

Suggestions–layout:

Titles of cases could be "expressions" or "experiments" rather than "methods". Perhaps narrative (synaesthete testimony) is common to all 3 expressions, and therefore you could frame the core method for the paper as the material translation of synaesthete accounts. This is not strictly a suggestion for improving layout, but one of structure, that will effect layout!

Review 2

Rating:

I feel this submission should not be accepted to RTD 2017.

Review:

This paper proposes synaesthetic phenomena as an inspiration and resource for design. It spends a good deal of space explaining what synaesthesia is, on the basis of neuroscience research and the accounts of people who experience it; and it describes

three prototypes, or studies, that seek to imitate these experiences and thus make them accessible for people who are not synaesthetic. This is an intriguing proposition, and the accounts of the people who are synaesthetic (emails presented as ‘images’) are very interesting. The design props, as the authors call them, also seem to offer unusual interactive and sensory experiences.

However, it is not entirely clear how this work fits within the context of—and contributes to—research through design. Most of the paper is spent setting up synaesthesia as a scientific area of inquiry (complete even with a graph showing dramatically increasing number of articles on synaesthesia in recent decades). And while it is nice to think of how design might be able to participate in this research, in the present disciplinary context of research through design there is also a need to demonstrate insight in the other direction—i.e., to show what this contributes to the field of research through design. As a simple indicator of the paper’s focus and context: all 9 references concern synaesthesia, and only 2 of them also concern design (and these 2 references are fairly weak). There is no reference made to current conversations and matters of concern in research through design, and little is said about the actual design process and rationale for the design studies presented.

Thus, while there are some interesting phenomena, concepts and possibilities addressed, this does not seem to be a top-tier paper that substantively contributes to the field of research through design.

Suggestions-content:

As stated in the general review, for this context the paper would benefit from significantly more focus on the design elements and relevant concerns in this work, rather than the current scientific discourse around synaesthesia. Some of the photos could also be improved (e.g., with better lighting).

Suggestions-layout:

There were images of the design studies well before they were actually explained in the text, which was somewhat confusing. This also reflects the overall balance of space and the amount devoted to explaining synaesthesia as a cognitive phenomenon versus the design process and results.

Appendix H: ACM CHI 2017



ACM CHI 2017

In March 2017, one of my works (prop 1) was published in a human-computer interaction (HCI) journal (ACM CHI 2017) as one of the tentative examples for qualitative displays and interfaces⁴⁶. This exposure of my prop and the translative property of synaesthesia in the domain of HCI afforded me an opportunity to speculate about the relationship between synaesthesia research and HCI.

⁴⁶

ACM CHI 2017:
https://www.academia.edu/32682549/Exploring_Qualitative_Displays_and_Interfaces

Appendix I: National Conference of the American Synaesthesia Association



National Conference of American Synaesthesia Association (ASA) 2017

In October 2017, I went to Boston to attend the National Conference of American Synaesthesia Association (ASA) at Harvard University as one of the speakers⁴⁷. I was able to share my research in front of some influential figures in synaesthesia research including Professor Edward M. Hubbard, Professor Takao K. Hensch and Professor Lawrence Marks⁴⁸. The feedback that I received from various audience members was thought provoking as they all shared their insights from their own field and perspective. During the conference, I also met Dr. Joel Salinas, whom I later requested feedback from regarding my research.

⁴⁷ My talk at ASA Harvard 2017: https://youtu.be/LErIgs58_M4

⁴⁸ List of presenters and info: <http://www.synesthesia.info/harvard.html>

Appendix J: Interview Content: Dr. Joel Salinas

Below is an email that I received from Dr. Joel Salinas, whom I interviewed for research feedback.

Q1. *What are your views on research that aims to create methods or approaches of applying the provocative qualities of synaesthesia as inspirational sources for generating creative ideas?*

I think it can be incredibly useful in the creative process, generally, and in design intended for humans. From the creative standpoint, simply making the designer/creator aware of cross-sensory associations can begin to reframe prior beliefs and assist with cognitive flexibility in developing "solutions" for a creative "problem" or question. From the design standpoint, I think it's critical that we take into consideration how human brains function to better understand human behavior and human experience. Drawing inspiration from synesthesia can create a more personal, seamless, and/or compelling design experience for the intended audience.

Q2. *In what respects do you think it would be beneficial for scientific-based synaesthesia research to look into creative application research? (you can talk from your perspective. So you as medical clinical scientist, neurologist and writer.)*

I partially answer this above, but would add that the application can be tailored to whatever area of the human environment that's desired. So from the medical perspective, for example, synesthetic considerations can help create an environment that maximizes cognitive-ease by tying together well-related sensory concepts and/or evoke a calm and pleasant sensory/emotional experience in setting that are typically stressful or hectic (e.g., a hospital room or a clinic waiting room). You can see existing applications in this area more generally in the design of clinical settings for children in pediatric hospitals. Another example, would be in the application of synesthetic considerations for experiences that we might not completely appreciate, like reading. Thinking of how typeface, typesetting,

page and cover texture, and the actual content of the writing come together (touch, sight, and even the sound of the mental words being read internally or even the entire mental landscape being created in the reader) can all create a more compelling and more vivid reading experience. I applied a lot of these concepts in writing my memoir, *Mirror Touch*. If you give it a read, you might be able to appreciate how I focused on the significance of every letter in the mental landscape I was composing with the reader.

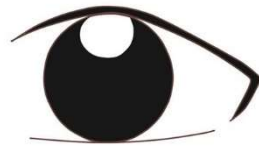
Q3. *Any general comment regarding my synaesthesia research would be appreciated.*

I think one really practical applications, which I suggested we could partner up on, is to develop a way to recreate a person's internal experience for other's to experience with their own senses. It can help with developing better communication and even empathy between people. If you're up for it or interested, let's find a time to discuss over Skype/FaceTime. Might be fun to prototype something small-scale as a start.

Appendix K: Request From Dr. Richard Cytowic

During my PhD research, I was very honoured to receive a request from Dr. Richard Cytowic to put one of my early motivational projects, *Essence in Space*, in his upcoming new book as an example of a synesthesia-based creative approach in modern day art practice. Some may think this is not a particularly interesting issue. However, as a PhD researcher who is exploring the subject of synaesthesia, I was highly motivated by this news. This kind of opportunity greatly encouraged my PhD journey and experience.

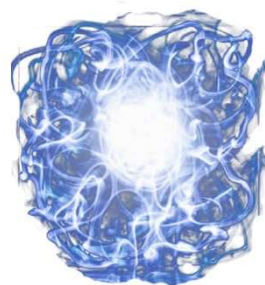
Appendix L: Workshop with Myself



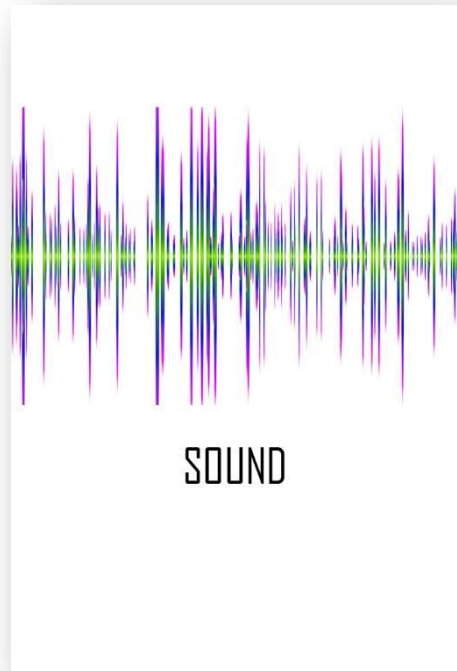
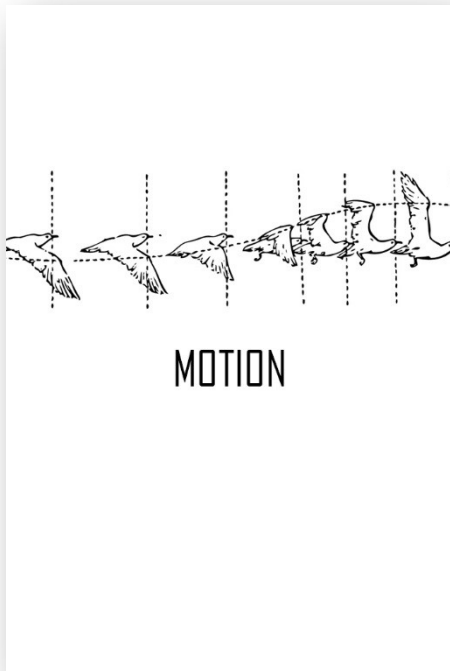
VISION



COLOUR



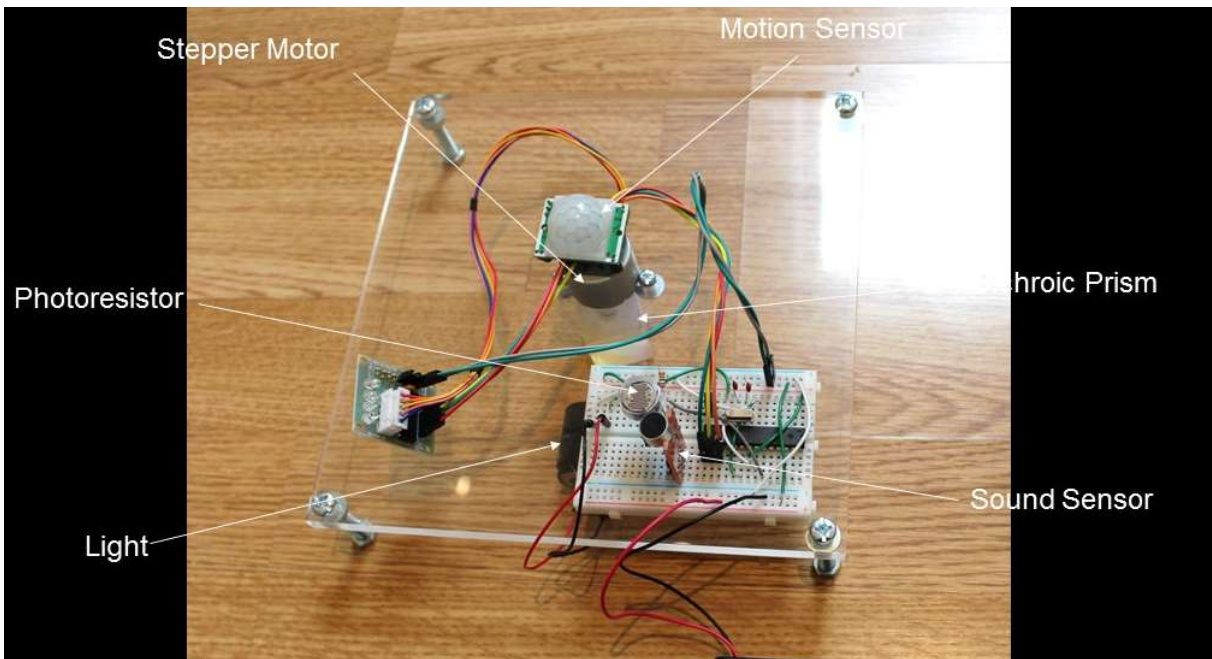
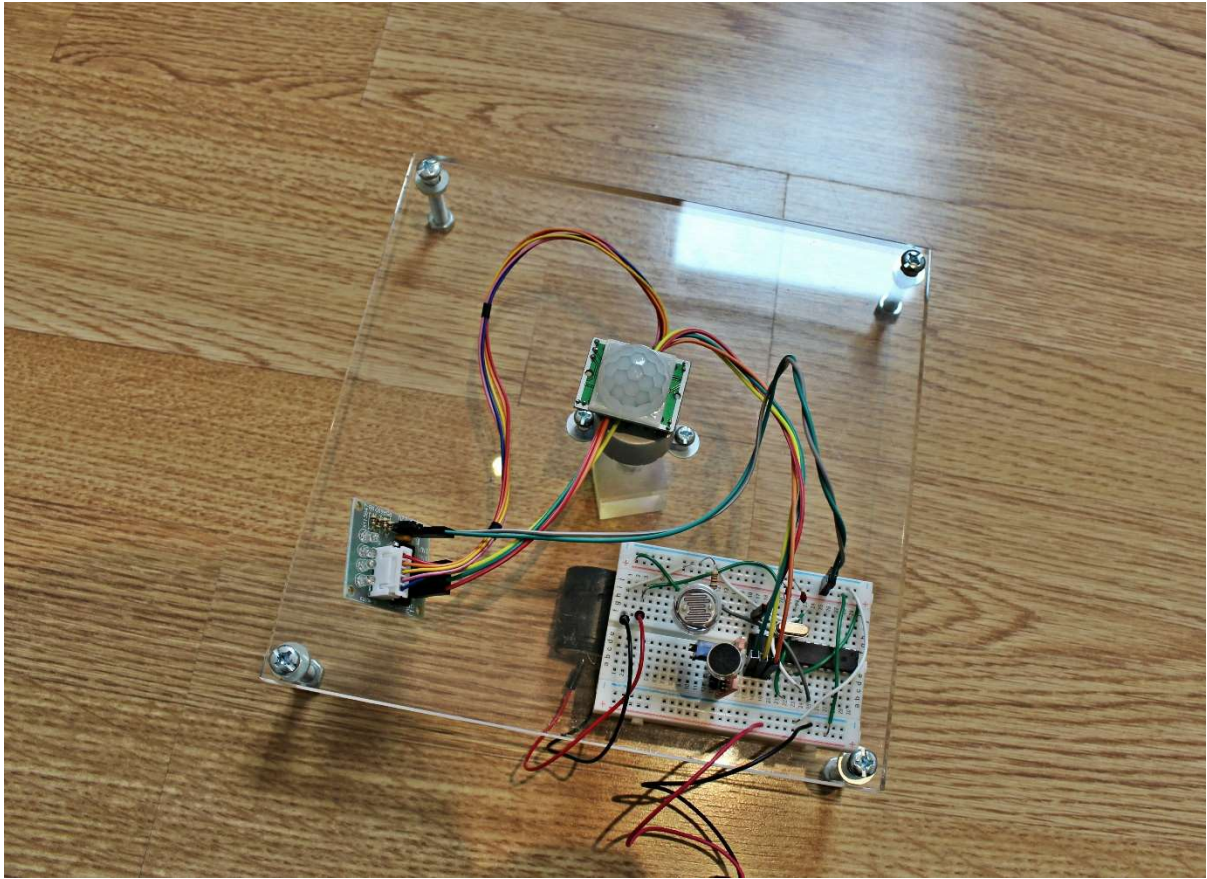
ENERGY



Vision, Motion, Sound, Colour and Energy used for Self Workshop

Although I was the creator of the synaesthetic-provocation toolkit, I wanted to know its usefulness and validity from the first-person perspective of a creator. It may be unfair, less effective and non-transparent to validate my own toolkit; however, I thought it can be one way of directly experiencing the functionality of the toolkit. To do so, I played with card-B whenever I had some spare time, as it is a relatively portable part of the toolkit. I played with the cards to explore the theme 2 (Playful Thing. See chapter: 5.3.2: Themes / Tasks) to create a playful thing for my partner.

P.S. *I am locating this workshop experience in the Appendices section as this type of workshop may be not a proper or rigorous way of sharing the validity of the toolkit to other people (readers).*



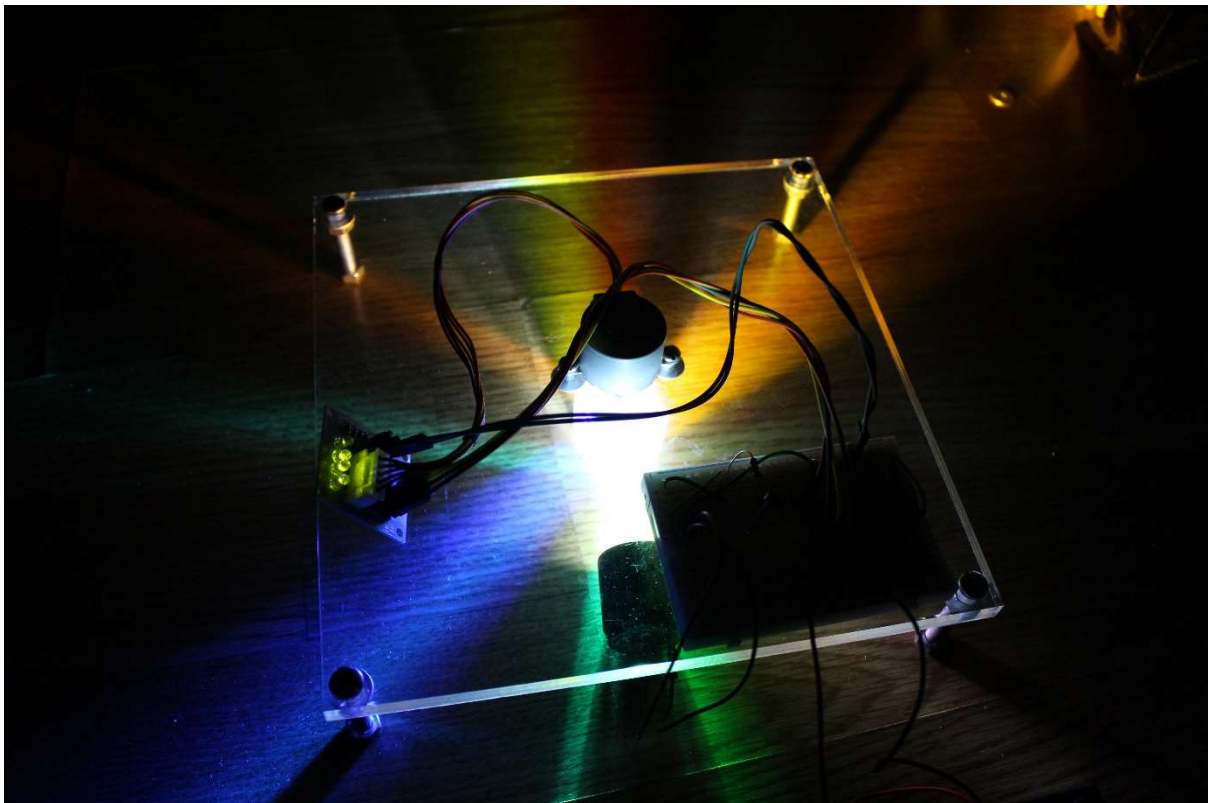
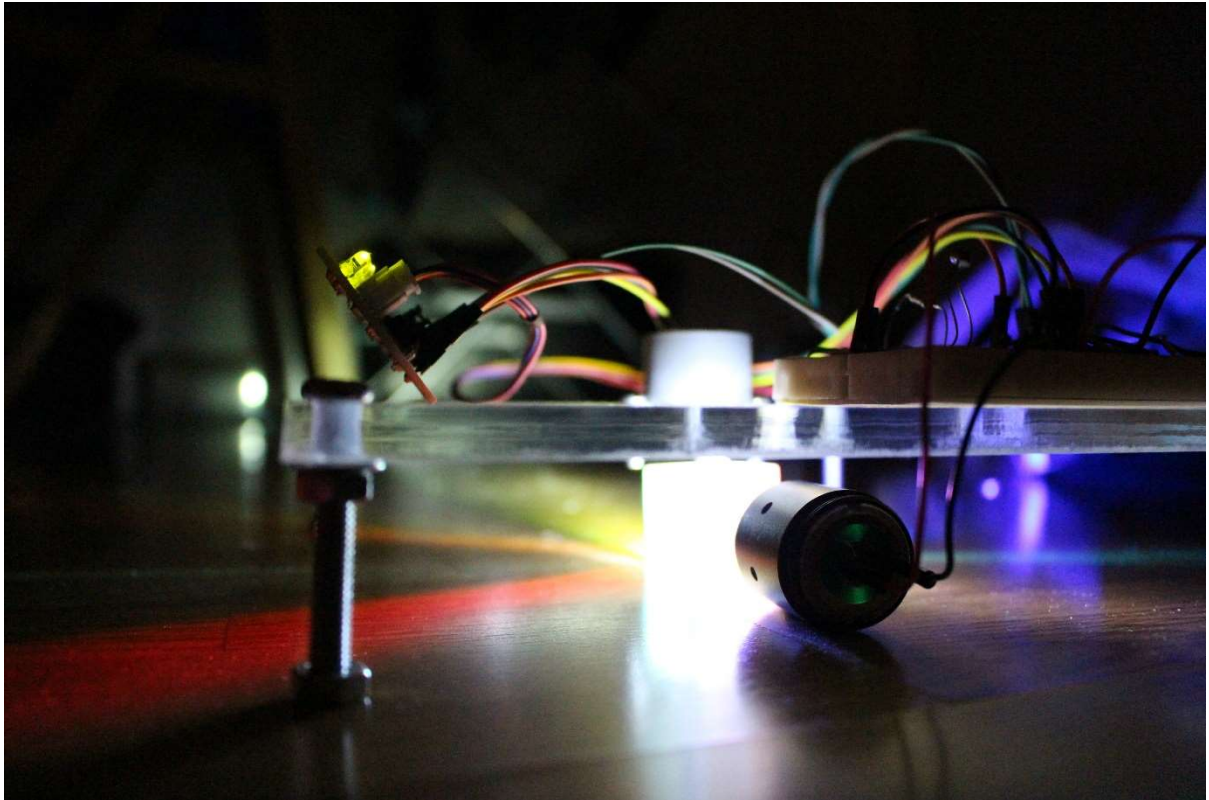
Silent Scene

One day, I was playing with some of the cards above (vision, motion, sound, colour and energy cards) while having my dinner. It was during the night and I was having my dinner, and this dark environment instinctively triggered me to create some sort of random,

playful lighting. This initial idea led me to pick the energy, colour and vision cards as I thought they could be helpful in generating a concept of lighting. While speculating through those three cards, I mixed the other two cards (motion and sound) as I imagined they could potentially evoke some kind of inspiration. The two cards later inspired me to add playful interactions to the lighting design; this lighting design then developed into a machine that only functions within absolute silence, meaning it only functions if there is no sound, no humans, no motion and no light surrounding the space, which means nobody can actually see its operation. As I have mentioned above, this lighting was initially designed for my friend, but she certainly did not like this idea at all. Nevertheless, I found this device playful in terms of its novel or unusual interaction. The card tools were used mostly as semiotics for this idea generation. The reason that I did not combine them as translation was probably because I had become rather tired with anything related to the subject of translation, as I had been researching this element for a long time throughout this PhD.

This device has a dichroic prism under the stepper motor, which is next to where the light beam is emitted. Whenever humans, motion, lights or sounds are absent within the space, it starts to refract and reflect the beam of light by rotating the prism and creating wonderful spectrums of colours ⁴⁹.

⁴⁹. Demonstration: <https://vimeo.com/257779013>



Silent Scene

Below is further project articulation and my investigation of the machine within a research context:

What makes us feel playful? What is a playful experience? Where does it originate from? How can we gain this experience? This project tries to explore, discuss and question the relationship between physical interaction and the experience of playfulness by demonstrating unusual communications between a machine and humans.

While many playful experiences may come from different forms of interactions (e.g., chatting, viewing, exploring, listening, learning and touching), this unusual machine, or device, does not offer any interactions to anyone. It is a stationary device that appears to do nothing. However, when there are no humans, no sound, no motion and no light within the environment, it secretly starts to create beams and rays of stunning colours. Unfortunately, no human can ever see this wonderful scene, as the device will not function if anyone is near it, which, for me and some people, is a kind of playful experience.

The aim of this project was to tangibly study and discover reasons behind a cognitively playful experience that would occur without any direct physical or sensory interaction. It attempted to demonstrate this cognitive state or experience by creating a novel machine that offers zero physical interaction, but can generate a playful phenomenon or cognitive atmosphere / engagement.

If there is a way to make someone feel playful without any physical and sensory interactions, where and how can we apply this approach or phenomenon to enhance human or users' experience? What can we learn from this type of novel interaction? This project attempts to create discussions around these issues to gain unusual insights relevant to cognitive experience.

This device has a dichroic prism under the stepper motor, which is next to where the light beam is emitted. Whenever humans, motion, lights or sounds are absent within the space, it starts to refract and reflect the beam of light by rotating the prism and creating wonderful spectrums of colours.

Appendix M: Stories From Synaesthetes

Story 1- AG

For most people, music can trigger emotional responses and can shift a mundane setting into an indulgent escape. Music can carry the listener out of gloomy thoughts into a safe distant space, and perhaps to a good memory. For me, a good tune not only fills my ears, but also fills my mind's eye with a visual landscape. Shapes and textures shift scale, move, and vary in monochromatic tones from the lightest whites to the darkest blacks. I like to describe what I see as a daydream which can be called upon when I choose to pay attention to it. Each sound has its own shape: round, sloppy, fluffy, awkward, large, small, sharp or jagged. A loud, low sound can be opaque, heavy, and might demand more of the foreground space in my mind. Quiet sounds can sometimes be transparent and weave in and out of the background.

I've experienced synesthesia as early as primary school when I spent summers dancing all day, trying to transform the shapes I could hear into movement. I have fond memories of a New Age album my mom brought home, the first instrumental album I heard, which brought me deeper in my exploration of synesthesia. The soundscapes of this music were very different because they did not have vocals and the shapes could be interpreted much easier.

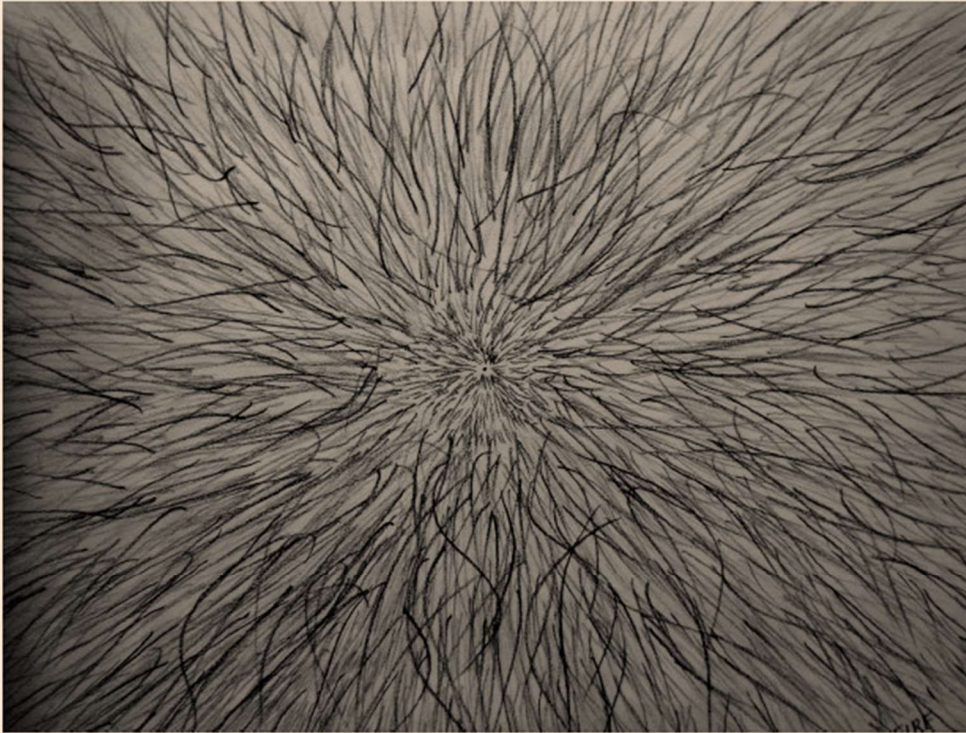
Until this day I continue to amount a large collection of music, obsessed with visual landscapes. There are too many albums to name but Radiohead's "Kid A" is more distinctive than others. When I listen to this album, the climaxes are like visual tornadoes where shapes are indeterminable from one another and occupy the space at the same time. When these climaxes end, a few quiet sounds escape and scurry out of the scene.

I am a professional visual artist and some music albums are banned from my studio because their visual landscapes make it too difficult to concentrate. When I am installing my paintings for an exhibition, I am aware that combinations of my works can pair shapes and tones together, and that certain shapes or tones create slight vibrations in my ear and mouth. Installing can thus result in sound-surprises. I am happy re-arranging the work on the walls until I find the right vibrations. I have often wondered if others can sense this, and whether visual art can move viewers at this strange subconscious level, in ways similar to music.

Story 2 - CM

One of my earliest conscious memories of a music-color experience was when I got my first iPod at 12 or 13 and listened to it in the dark. Brightness exploded around me in shimmering pinks, whites, and pale green. Often I keep to myself because the noise and crowds of the world can be overwhelming. I don't like it when someone asks me my preference in music since I can't describe it how they would expect. But I've always loved classical music for the string instruments that create ocean waves of maroon and violet. Recently I have tried more energetic genres like EDM, and Dubstep to push the limits of what I thought my brain could experience. In one song, I caught a fleeting image of a glowing green ball inside a three-dimensional box made of gray smoke. As silly as it might sound, this was a truly exhilarating moment.

Story 3- LG



Hello Mr. Lee,

When I am angry or frustrated, I see something that looks sort of like fire coming at my face (I've attached a drawing I made of it - it's in black and white, but it looks red and orange when I experience it). It is quite painful, and I hear something that's sort of like wind or white noise along with it. If intense enough, I won't be able to see much else for a while, and I won't really be able to think that much for several hours after it's over. I'll either be blank or have thoughts that repeat a lot; especially if whatever went wrong went unresolved. For this reason, I usually try to avoid situations that would cause this.

I'm glad that you are researching this - I've been wanting to contact a researcher about it for a while now (so I can understand it fully, and maybe get an MRI done or something), but I don't really know if inducing something like this for a study would be seen as ethical.

Story 4- [REDACTED] DD [REDACTED]

Dear Diary,

Today, after my birthday party for my eight years, I had an argument with my sister. I was saying that Saturday is red and she insisted that is yellow. Suddenly, my mother came into the room and yelled to us: Are you both crazy, young ladies? What red and yellow? Saturday is as blue as the sky is today! I don't know how to tell her to go to a doctor for her eyes...

Story 5- [REDACTED] JW [REDACTED]

As a child my daily trip to school included a ride on the London Underground subway system.

The sensory experience within a busy Tube station was rich and impressionable but the one sense that dominated all others was flavour. I could literally taste the Underground.

The whine of the motors as the train pulls out of a station causes my mouth to fill with a taste and texture remarkably similar to stewed rhubarb.

Each and every station I pass through or stop at comes with a specific taste, texture and temperature all of its own and for me, riding the Underground is akin to travelling back in time, sampling once again all those wonderful flavours from childhood: Sherbet Flying Saucers, Milky Bars, Love Hearts, and Jam sandwiches. And long lost ones such as Aztec Bars, Opal Mints and Spaghetti Hoops.

I have always navigated the Tube system by taste or rather by taste sequence, with the station names becoming totally irrelevant. This is my interpretation of Beck's iconic tube map depicting my synaesthetic journey around the entire London Underground, DLR and Overground systems.

Story 6- ██████ MG ██████

My lover massaged my sore back yesterday. Lots of tight, yellow colours in the lower, right side of my back that gave the taste of off cheese - it made me gag and saliva came into my mouth as it does before one vomits. In the area that was most sore it was an empty, ominous black. The depth of the blackness made me concerned about the extent of the damage.'

Other parts of my back felt rapturous to his touch - the base of my spine was suffused with a vibrant orange of Indian silk and was accompanied by the smell of orange blossoms in a night time garden. The orange blended upward into a particularly beautiful shade of radiant, mango-blush pink. When his hand moved from one location to the next it came with a swish of white which quickly evaporated as new colours appeared. The circular motion of his warm hand on my left shoulder exploded into multiple, joyful rainbows one after the other. Transcendent, somnolent bliss!

As his massage continued, healing gold encroached the blackness in the sore area and it began to feel better. I knew then that my back was going to recover.

Story 7- MH

My synaesthesia colours

1 White	A Red	K Brown	U Sky blue
2 Green	B Dark green	L Dark blue	V Purple
3 Sky blue	C Yellow	M Crimson	W Green/Orange
4 Crimson	D Brown	N Dark blue	X Grey
5 Cream	E Cream	O Black	Y Cream
6 Cream	F, Cream	P Sky blue	Z Black
7 Dark blue	G Brown	Q Grey	
8 Dark green	H Cream	R Brown	
9 Brown	I White	S Sky blue	
0 Black	J Dark turquoise	T Cream	

The association of white with 1 and I and black with 0 and O could mean that I did not know the meaning of the symbols when I acquired the association, suggesting that my explanation of the trigger for my synaesthesia is correct.

MH, February 2015

Story 8- SJ

I am an alien. I am sure nobody else in this room tastes Marmite when they hear the word 'life' or Plumrose tinned cream when someone shouts the name 'Molly' or strawberry jam when someone calls 'Robert.'

They are sound-tastes associated with childhood and food I no longer eat but can still taste clearly when I hear the words.

At school when learning to read I said I didn't like the taste of the word 'complain.' It conjured the taste of digestive biscuits – too dry for a hot day in the classroom

The teacher told me not to be silly. We were here to read words not eat them. By lunchtime I was too full of sounds to eat school dinner and ended up standing in the corner for being wasteful.

Scientists now see my condition as something special. I am a velvet clad laboratory rat. I am a celebrity – I've been on the telly. Watch out Big Brother!

Story 9- TL



I have always experienced sounds as having shape, weight and texture. I like to listen to music filled with thick textures and shapes that move around me. When I go to concerts I love how big shapes appear that I can dance with.

When I'm out an about, shapes can distract me, stealing my attention from what is going on in the "real" world. This is usually very exciting but can sometimes be disconcerting or even dangerous. Once, as I was riding my bike, a bus put on its breaks right next to me. The screeching sounds threw a big shape around my head causing me to have to stop in my tracks.

Some years ago I began hunting sound shapes. I capture them with a recorded and take them home where I put them in soundscapes with other shapes, which I draw and paint.

Story 10- [REDACTED] JD [REDACTED]

Hi, everyone,

To add to Chang's 'anger' question/conversation, reading about people's stories makes me realize I do have one small reaction to anger (only the most extreme anger), which is sort of like a black cloud off to the side – I think always up and to the right. For a long time, I thought it was imagined, like how we use figurative language to explain how someone looks at someone 'darkly'.

I found it interesting that someone else saw orange during anger, when the only time I've ever seen orange (sort of a sunrise/sunset orange) was during a very pleasurable, happy moment. Other than those two extremes, emotions don't bring out color for me.

I don't mind if you were to share this if you wanted, though it's pretty tame, compare to other people's experiences!

[From: K
17.Feb.2016

Hi, Chang,

So, 'electricity' is one of those words that is very thin in consistency – like putting a sheet of paper in your mouth with the taste on it – a little hard to get, and a little... unsatisfying.... because you know the taste is there but you can't quite get the full sensation because the consistency is so 'thin'. A good analogy maybe is wanting to eat ice cream or something rich but only being able to lick an ice-cream flavored piece of paper A lot of words are like that actually. (Off the top of my head, Lindsay, and Linda are a couple of names like that – Lindsey with an 'e' is even thinner, I think because it doesn't have that voluptuous 'a' in it to round it up). An 'l' a hard 'c' or an 'i' in word – depending on placement and combination with other letters – tends to make it thinner. I'm really visual (apparently there is something called 'ticker tape' synesthesia, which I never knew was a 'thing', but to the degree it is, I evidently have it). I 'see' everything said or heard in writing, so the spelling and letters can make a difference in how a word tastes.

Breaking it down, the first two syllables, 'ele' if taken alone, are deliciously vanilla whipped-cream full and satisfying (the vowels 'a' and 'e' usually do that, give a fluffy and full consistency). But as soon as the 'c' gets in there – which tends to harden things up a lot – that all dissipates. The 'tricity' part dominates the fluffy whipped cream part (not sure why? Maybe because there is more of it) and it is thin and hard to grasp ... like water. A 't' often makes a word thin too. (But sometimes 'th', especially after an 'a', makes it really fluffy).

The overall effect is like drinking soda water. The thin consistency and the pingy bubbles (that kind of give it a little body, maybe as a nod to the full 'ele' syllables?) do this, but so does the fact that the word disperses all over the inside of the mouth (oh, I also feel different words in specific places in my mouth) – like water, but still has definite sensation (the bubbles) more than definite taste.

As an aside, the last name of Dr. Richard Cytowic also tastes like soda water. (I told him this years ago, when I was corresponding with him on his work!) The bubbles in his name are much more pronounced, however – it is, like, all zingy bubbles. When I examine that, I'm thinking it must be because of all the hard letters in both words, but his lacks a softening vowel, as the word 'electricity' does not. And, I'm thinking (but I'll have to give this some more thought, never paid attention before) that it might well be the 't' in both words that is so responsible for the zingy, active sensation that makes me equate it with carbonated bubbles. 'T' is generally a very pleasant and refreshing letter in a word, very green-tasting. (I know I just said that, but I'm not really a color-related synesthete, at least not that I've ever identified with).

Anyway, I hope that helps.

I would be happy to elaborate if you need.

Best,
K

Story 12- CMY

I have a form of Mirror Touch Synesthesia.

I receive painful, electrical-type *shocks* – I call them *zaps* – in the area between the base of my throat (the 5th chakra) and the center of my chest (the 4th chakra). I experience the pain within a range of 1 – 5 with 5 being strong enough to fell me. I have been known to receive a barrage of *zaps* on any given day but sometimes there are only a handful. Mostly the pain from the *zaps* fall within the 2.5 – 3 range and that is very doable. But then there are the stronger *zaps* and when they find me I gasp out loud, clutch my throat and chest, and then have to literally sit down to recover.

The zaps are triggered by other people's physical injuries although sometimes my own injuries can be a trigger. I can't watch when the needle goes into my arm for a blood test for instance. That one is a 4.5 provoking an OUCH that the lab technician does not appreciate.

Here is a list of the sources that have been known to trigger *zaps*.

Seeing someone else's physical injury (and my own if I have one)

Hearing about someone else's physical injury

Watching a film or a television program dealing with physical injuries (when I see graphic images)

Reading something about someone's physical injury.

Also, Remembering someone else's physical injury (or one of my own)

Imagining someone else's physical injury that might happen in the future (this is a new one!)

Also, lately I've been receiving zaps when I actually see or hear about an animal's injury in the present, past or future. This one is also new.

Mirror Touch Synesthesia as I experience it is different from compassion. It is an actual, physical, sensation due to a hiccup in my brain wiring. The *zaps* are not due to my feelings of empathy or concern in other words although I often experience these feelings in addition to the Mirror-Touch.

Story 13- [REDACTED] SH [REDACTED]

I have always hated feeling angry. I think that because of that, the colors are a bit different than if I let myself be just angry. As far as I can tell, the anger is a rusty orange that looks very fuzzy at the edges of my vision. But it usually is accompanied by a sickly yellow-green at the pit of my stomach.

For "pain" as you asked, it changes according to what is causing the pain. Achy joints look like orange hoops, stomach aches feel like big purple marbles. Some sharp, shooting pains look like shark bites in my mind and having bright, alternating lines through them.

Another that I thought I would mention is shock. Like shock when you hear something terrifying or sad. It starts as a pink and orange wave that rushes over my face, and then turns into an orangey yellow that sits at the end of every nerve in my face.

That's all I'll get into right now, because I don't want to go on forever. I hope it was helpful!

- [REDACTED] SH [REDACTED]



UK Synaesthesia Association

Dear UKSA Members,

We have received a media request for short stories of personal experiences of synaesthesia for an upcoming Art Exhibition directed by Chang Hee Lee from the Royal College of Art. If you are able to help, or require more information, please contact Chang directly at changeheelee@network.rca.ac.uk

All the best,

GHF

UKSA Membership Secretary.

Dear UKSA members, I am looking for short stories of experiences of synaesthesia for use in an upcoming Art Exhibition. Any experience of any type of synaesthesia would be appreciated, the stories themselves should be between 50 and 150 words, so quite brief. A good example is one I found from Richard Cytowic's book 'Wednesday is Indigo Blue' (p.4) "I heard the bell ringing... a small, round object rolled before my eyes... my fingers sensed something rough like rope... I experienced a taste of salt water... and something white." I am expecting to create an exhibition by displaying 10-15 diverse props that have different stories of synaesthesia. The purpose is to expose speculative property of synaesthesia to the general public (I am primarily targeting the V&A (Victoria and Albert Museum) for August. To contribute please provide me with a story about your synaesthetic experience (and what types of synaesthesia you have). Ideally I would like to collect these stories before the end of May. Since the display of these stories is to the general public, the media may be interested in covering them. Unfortunately I won't be able to offer any reimbursement, I am happy to list your name with your story if desired. This information will also be included in my PhD thesis. To contact me please e-mail me at changhee.lee@network.rca.ac.uk I have included some details about myself below:

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