Materialising the Immaterial: Provotyping to Explore Voice Assistant Complexities

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ABSTRACT

Voice assistants (VAs), typically promoted as omniscient conversational butlers, still remain below users' expectations. Interaction designers seem to struggle bringing in user perspectives necessary to develop more meaningful VA applications beyond simple use cases such as playing music. One of the reasons might be the immateriality of cloud-based VA technology making it difficult to comprehend such complex and ever-evolving systems. In this paper, we investigate provotyping as a design tool for 'materialising the immaterial'. In our case study, teams of multidisciplinary experts devised twelve provotypes to explore intangible VA technology. We present and discuss three generalisations in respect to the role of provotypes for the exploration of VAs. Our findings show provotypes can serve as the necessary props by which we can bring in missing perspectives around this technology and generate material which enables designers to speculate, debate, and sketch out ideas for meaningful futures of VA applications.

CCS CONCEPTS

• **Human-centered computing**; • **Interaction design**; • **Interaction design process and methods**; • **User centered design**;

KEYWORDS

Voice Assistants, Research Through Design, Speculative Design, Provotyping, Prototyping, Artificial Intelligence

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1 INTRODUCTION

Our intention in this paper is to build on speculative design's potential to exaggerate or isolate Voice Assistants (VAs) from their original intent to be able to re-evaluate and interpret [36] their meaning and provoke future narratives from an interdisciplinary research team. In order to disrupt the starting point of the existing consumer narratives proposed by existing VAs such as Amazon's Echo, Google's Assistant and Apple's Homepod, we propose that by isolating and closely examining smaller elements of a VA in a more material manner, we can begin to better discuss the many different complexities of these devices. These discussions led us to uncover and unpack three complexities: *The complexity of Artificial Intelligence (AI) smartness*; *The complexity of forms relationship to cloud computing* and *The complexity of our relationship to our data.* These complexities were otherwise undetected through traditional research studies. An overview of these complexities is filled by a discussion on how to take these complexities into consideration when designing for VAs. These complexities stem from a lack of understanding of both capabilities and limitations of VAs, and more so a mental model of how these devices work. To further broaden this lack of understanding and confusion there is a lack of an established language to use when describing how intelligent an AI is.

The provotypes are explored in two workshop events where they were used as a method to explore VA futures and subsequent discussion in a multidisciplinary research team. The workshops were part of the VA-PEPR [1] project. The project conducts research into how people experience voice assistants in their homes and

[1]Project website: https://sites.hslu.ch/va-pepr/en/

private lives and how they develop new practices and routines around their use of VAs. By focusing on the home environment, user experience, and ethical issues, the project aims to contribute to a deeper understanding of this new technology.

The provotypes were designed based on insights gained around future VA use encountered in the participant interviews (a previous in-home study with 31 participants engaging with VAs). However, as others have found, it quickly became clear that VAs are an emerging and particularly imperfect technology, which proved to be difficult to integrate in everyday routines. Instead, VA interactions often remained limited to a few basic functions: music, search and smart home control [3, 22]. What we found in this initial phase of the research project were instead questions, frustration and insecurity from VAs being embedded in a complex system of interrelated, evolving elements. This makes it difficult for users to have control - e.g., over processes or activities with VAs. Lack of control was typically coupled with a lack of trust towards the device, loss of interest, termination of use and/or paranoia. Provotypes were then used as methods that are suitable when trying to test, re-imagine hypotheses - in this case about future VA use [43].

By discussing key issues from the interviews with members of the project, the research team developed twelve provotypes that materialised the immaterial and allowed the team to speculate upon these isolated and sometimes exaggerated elements of VAs. In doing so the multidisciplinary team were able to uncover three otherwise undiscovered complexities within the project research.

We will discuss the complexities that these provotypes uncovered, and how to take these complexities into consideration when designing future VAs.

2 RELATED WORK

The research builds upon four strands of prior work related to materialising immaterial in relation to VAs. Firstly, we overview research on the relationship we have with our immaterial voice. This is followed by an overview of the intelligence of VAs. Thirdly we return back to the immaterial and explore implications of making this physical. The final section of related work explores the role of provotyping as a research tool.

2.1 Speculation and Immaterial Voices

The nature of voice has long been a subject of speculation. In the exhibition, Atmospheric Memory, the curator Irini Papadimitriou, recalls a text from Charles Babbage [6] where he speaks of "*The air itself is one vast library, on whose pages are for ever written all that man has ever said or woman whispered*" [33]. There is a sense that Babbage, having designed, but not built, the world's first computer, was turning his calculating machines to the ether. He proposed to find order in chaotic systems with highly precise measurement, through which we would be able to recall anything that was ever said by sampling the air. A wonderful poetic imagining of the impossible. This impossible speculation doesn't seem so far-fetched if we stretch the framing. What if, everything we spoke was captured not in the air, but in silicon. That a vast library could be formed in remote data clouds. Impenetrable to humans, but readable by machines. VAs that were borne out of scientific and literary speculation are being reshaped by design speculation. Rogers et al. [35] use props in films to speculate on the nature of internet health of VAs. In a similar approach, Parviainen and Søndergaard [34] use short films to expose trust in terms of our willingness to share and show vulnerabilities with machines. Seymour and Van Kleek [36] ask us to question our trust of VAs by using design fiction to exaggerate our relationship with non-human machines, but that behave as if they are, in order to establish that VAs are clearly "*not our friends*". In doing so they highlight the need for designers to think beyond servitude and include ideas of machines that "push back". Cambre et al. [8] use participatory story completion to elicit far-future (in the year 2050) stories from participants. Their work draws on collective storytelling from 141 contributions in order to identify themes in public perceptions of preferable voice futures. They identify that perceived futures included "mundane perfection" scenarios alongside "rich interactions" where machine intelligence often superseded human intelligence. Taylor et al. [40] use provocative voice prototypes to expose tensions in VAs to Mozilla technology developers as a way to introduce Research through Design's value in the development of future VA systems. Through the use of physical objects, rather than 2D sketches, the "*intention of the concepts became clearer*". This overview highlights the complex concept of the ownership of our voice, and what happens when it starts to be collected by physical objects in our homes contributing to never-ending data sets.

2.2 How Intelligent are VAs?

The sense that machines can and will be more intelligent than us naturally sets the scene for cautionary futures. In the 2021 BBC Reith Lectures, Stuart Russell [5] specifically calls for Artificial Intelligence to be separated from the control of lethal weapons. In his view, it is not a question of if, but when, AI exceeds human intelligence in many applications. However, he also cautions that we do not as yet have a way of describing or quantifying machine intelligence - there is no IQ test for machines. This inability for humans to perceive the intelligence of machines is important in relation to VAs. Wallace et al. [42] describe the Internet of Things (IoT) as having technological capacity on the inside that far exceeds our perceptions of the object from the outside. They call this the TARDIS effect, a name taken from the British Sci-Fi series Doctor Who, in which the hero travels through space and time in a telephone box that is far bigger on the inside than the outside. Up until Smart Speakers and VAs landed as small boxes on our kitchen worktops, our perceptions of a radio speaker were very much form-follows-function. This is when the function was determined by tuning into specific radio waves in order to induce sounds in a speaker. The "insides" of a VA, as shown by Crawford and Joler's "An Anatomy of an AI System" [10] are beyond our everyday comprehension. Which takes us back to the kind of speculations that Charles Babbage was making nearly 200 years ago. Both the Anatomy of an AI and the TARDIS effect suggest that there is much unknowns about the workings of a VA, particularly to a layperson. Unlike Doctor Who we can't look inside our TARDIS (VAs) as easily, and if we could there's a good chance we wouldn't know what we were looking at (Figure 1).

Figure 1: The "TARDIS" effect of a VA.

2.3 Designing for "Invisible" Technology

How do we design the services and products that users engage with when dealing with cloud computing? There are two aspects to this. Firstly, designing feedback systems - in other words how do we make users aware of what's happening when they interact with these invisible systems. Secondly, designing the "thing" itself - how do users know what to interact with in the first place. Both these aspects are becoming increasingly important when designing for VAs, and this goes well beyond the interaction design for systems or product design. It starts to ask questions of designing for privacy, control and transparency. Questions explored by Rogers' et al. [35] in an exploration of advocacy for a voice enabled internet through a series of physical props. This has been picked up by Chatting et al. [9] in a more general approach "*to prototype new metaphors and design patterns"* in order to make invisible computations *reappear* for users, improving their privacy and security of smart devices. Wallace et al. [41] posit that by making complex data visible in a physical way we are able to make it more personal and meaningful to users. It is as if bringing this data into our physical environment and allowing us to touch it we are instantly more invested and connected to it. This harks back to the notion of physical proximity playing a role in the perceptions of ownership. The closer you physically are to something the more you feel the right to own that thing [31]. Taylor et al. [39] used dynamic physical representations of pie charts and bar graphs to show higher engagement between users and data due to the compelling and *"eye catching and legible"* or glanceable [26] information - in contrast with screen based static charts and statistics. Taylor et al. [39] also agree with Wallace et al. [42] in the notion that a physical representation of data allows onlookers to see it in a more meaningful and relevant way, allowing onlookers to make a real-world connection with data. The "TARDIS" effect of VAs leaves many aspects of their functionality and capability invisible. It felt appropriate for this study to draw out the VAs invisible characteristics through the medium of provotypes. Intelligence is something that at the moment we do not have the language or metrics to quantify - which leaves us in a liminal space between what we can observe and what we can measure. This then leaves an open door to claims of smartness. The challenge for much of VA technologies is their tendency to overclaim the "intelligence". Lahoual and Fréjus [22] for example found that trust was increased when users better understood the intelligence of a VA - but that this took time for people to get to know their VAs and their capabilities meaning that "intelligence" is locally defined for each user. Ammari et al. [3] discuss the limitations of VAs to contextualise. Reporting that users found difficulties specifically with VAs being able to perform temporal contextualisation when setting calendar invites and spatial contextualisation challenges with regard to switching on the right light bulbs. The invisibility of intelligence is hiding in plain sight. Leaving users to form their own naive definitions. Provotyping in this project was used to expose and investigate these different forms of unknown within VAs. These examples give a case for materialising the immaterial in order to allow people to better connect with something that was previously either invisible or too complex. This approach feels highly relevant to the communication of the unknown elements or capabilities of VAs.

2.4 Provotyping as a Research Tool

Provotype, a portmanteau of Provocative Prototype, is a method usually used in the early exploration phase of a project with the aim of provoking a reaction or conversation, they are designed to not refine our thinking but rather expand it.

The term provotyping emerged from the systems design community in the early 1990s [30]. Here provotypes were used as a method to "*provoke the taken-forgrantedness of everyday practice, by exposing discrepancies in the practice through prototyping*" [7]. In other words, provotypes were used as a series of experiences that allowed systems designers better understand how to create better systems. Rather than using provocative prototypes purely for the sole purpose of provoking, as is typically achieved in Speculative Design [4]. Provotypes have been developed further, predominantly by Boer et al. [7] as a research method to help provoke and stimulate conversations. In this case provotypes are seen as a participatory method - with the thinking that by running provotype workshops with end users you are able to uncover new lines of inquiry. Provotypes can also enable "*untested hypothesis about the future that can be accepted, rejected, or re-imagined"* [43]. That speculative design often has ambiguity built in [16] it is not surprising that there are also times in which research objects can *"unintentionally act as Provotypes"* [32]. However, we note that the nature of provocation is rarely discussed. The hyper dystopian approaches of Critical Designers (e.g., Auger, Dunne and Raby [4] is a stark contrast to the more utilitarian approaches of Odom and Gaver [32, 44]. The physical and probing nature of provotyping aligns with this research - to isolate and materialise complex elements of VAs with the aim of generating discourse, helping us to better understand the capabilities and our relationship with these complex devices.

3 METHOD

This section outlines the strategy that supported the investigation of this paper in a valid and transparent way. Key aspects of the

Table 1: The 12 provotypes with a brief description.

	**1. Super Hearing** This provotype (voice skill) explores what it could mean if our voice assistants could hear and make sense of more than just the spoken word		**5. Constant Transcriber** This provotype (3D print + electronics) prints out everything it can hear - or rather what it thinks it can hear		**9. Data Flow Customisation** This provotype (mock app) explores what it might be like to be able to customise a VAs 'smartness', and what it means for the functionality of the device
	**2. Take Me To Church** This provotype (video) explores what it might be like to treat a VA as an emotional support device		**6. Data Value Monitor** This provotype (mock app) explores what it might be like if we could see the value of data our VA was collection on us		**10. VA Everything** This provotype (3D print and stickers) explores what it would mean if we could turn everyday objects into a VA simply by placing a sticker on it
	**3. VA Everywhere** This provotype (3D printed phone case) explores what it might be like to have a VA in your pocket at all times		**7. Microphone not Speaker** This prototype (3D printed prop) explores what it would be like if the form of a VA resembled a microphone than than a speaker		**11. Extra Control Dial** This provotype (3D printed dial) explores what it mean if there was an extra control dial that you could stick onto a VA allowing users to turn 'something' up or down
	**4. Data Control Services** This provotype (flyer) explores a future where we need a specialist service to fix home data problems such as data leaks, data infections, AI bias and data fraud		**8. VA Confessional** This provotype (wooden prop) is a playful provocation that asks people to imagine what it might be like to be able to interrogate an AI, like a confessional session with a priest		**12. Data Packet Viewer** This provotype (image) explores what it might be like if we could see and touch data packets moving from one device to another within our homes.

strategy explained are the motivation for a case study-based research approach and the selection of the empirical basis and the international, multidisciplinary research project as a context of this investigation of provotypes.

3.1 Motivation for a Case-Study Research Strategy

Since the aim of our research was to explore a situation in which "the intervention being evaluated has no single set of outcomes", a case study approach appeared particularly appropriate to investigate the various different outcomes of the workshops [44]. To increase validity, the study combined multiple sources or "full variety of evidence" [44] - participatory observation; workshop material and emails - in a case study approach (ibid.). To ensure credibility and validity of the data analysis we included four researchers in the data analysis process [24]. An inductive research design that develops concepts, categories, and relations from empirical data [14] was most suitable as we were interested in gaining insights from analysing concrete provotype workshop experiences that served to explore VA complexities.

3.2 The Provotypes

The provotypes were borne out of a team workshop where insights from the previous project research (literature review and user studies) acted as starting points for idea generation. 12 provotypes were selected to be developed and presented during the two team workshops. These 12 provotypes were developed together by different members of the team. Table 1 shows that skills of Graphic Design, UX Design, Illustration and Product Design were used to create provotypes in many mediums (products, videos, graphics, apps, and voice skills).

3.3 Evaluating the Provotypes

The evaluation of the provotypes took place in two online workshops held in December 2021. For each, 6 participants from the research team used the digital whiteboard Miro (due to restrictions imposed by Covid-19). The researchers participating in the workshops were experienced in collaborative design, research through design, creative technology researchers, human-centred design (workshop 1) and in social sciences, ethnography, business administration, innovation management, computer science, process management and AI (workshop 2). Both workshops included senior researchers and early-stage researchers, participating in the role of informed end-users. A total of 16 participants discussed in total 12 provotypes. These internal workshops formed the basis for our participatory observation. To tease out the relevant aspects of the role of provotypes in exploring complexities of VAs, we examined the workshop results and materials from follow up team conversations.

Workshop participants received a general introduction to the purpose of the provotype workshops and were then introduced to the six provotypes they were to use for their inquiry. Participants were invited to run through a couple of questions – such as "What does the idea provoke?"; "Who does this provoke"; Where does this provoke?"; "When does this provoke?" – and "Why does this matter?" For the second workshop, the methods were adjusted based on participant feedback from the first workshop. Workshop 2 thus allowed a more organic approach to the questions while workshop 1 presented the questions in a linear and sequential fashion. The change aimed to promote greater interactions and engagement for participants and produced a more dynamic setting for online workshop 2. Overall, 715 written comments (in form of post-its) were collected during the two workshops. Subsequent email discussions following up on these comments started immediately after the workshops and were included in our analysis. The correspondence happened between the workshops (in December 2021) and the end of February 2022 (writing of this paper).

3.4 Data Analysis

To analyse the provotype workshop results (Miro-board comments relating to different levels of the provoking function of the provotype), four researchers analysed comments that were entered (collected as Word documents) with a qualitative approach – involving coding the comments where feasible; sorting and sifting through the material to identify common themes or patterns. For reducing the influence of own recognition patterns and increasing the interpretive validity, two researchers from the same dataset came together, compared results, and developed a common interpretation. The results were then discussed among the four researchers in a third step to gradually arrive at a small set of three generalisations (themes) in respect to the role of the provotypes for the exploration of VA futures. These generalisations were presented to two senior researchers of the research group in a final step to not let generalisation go unquestioned [28]. As the overall aim of the qualitative analysis was to openly study the role of provotypes to explore VA complexities, data from the workshops was not approached with predefined categories from literature, but instead analysed in a bottom-up approach, which allowed for the emergence of themes from the material [23].

The emails and conversations representing the discussion following the workshops were called-on after the analysis of the workshops. The analysis here focused on substantiating or contradicting the three themes we had found in the analysis of the workshop material. We also looked to treat the three themes we found across several provotypes when examining these conversations [28].

4 RESULTS

This section presents the results from the two online provotype workshops. This section closes with an overview of the three themes identified in the analysis of the workshop material and subsequent mail conversations.

4.1 Key Findings from Workshop

Table 2 gives an overview of the most insightful workshop responses for each of the 12 provotypes. These post-it notes were written by the participants responding to the conversations undertaken during the two provotype workshops, Workshop facilitators helped in guiding the participants to unpack the interesting points raised during these conversations.

4.2 Uncovering the Main Themes

The coding of the workshop content provided three new themes that were otherwise undetected from the project's other research streams and contextual/literature review.

The majority of the themes uncovered from the workshop responses were not insights as we were expecting, they were in fact mainly questions, or speculations. These speculations manifested as either questions about possible futures and/or speculations about VA related product or service ideas. The coding that emerged from the provotyping workshops aligned with the themes generated from the parallel research streams within this project. The main difference was how these themes were framed -the questioning nature of comments added new lines of inquiry. They highlighted three themes that there was either confusion or complexity around.

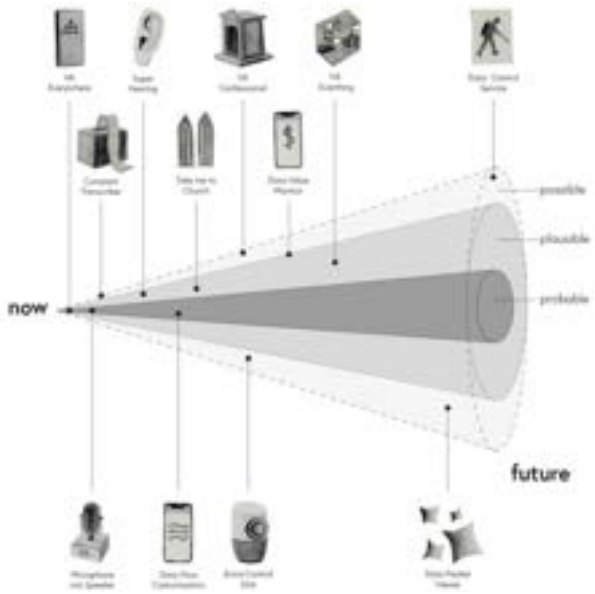

Figure 2: The twelve provotypes placed in a futures cone.

These themes were further examined resulting in the definition of three clear areas of complexity that were prominent from the results: *The complexity of AI smartness, the complexity of forms relationship to the cloud* and *the complexity of our relationship with data.*

4.3 How Provocative Were the Provotypes?

Naturally some of the provotypes proved more provocative than others. Figure 2 illustrates the 12 provotypes positioned on a futures cone. The more provocative provotypes are either far future concepts due to technology capability or on the edge of possibility due to other non-probable factors such as a change in privacy laws.

5 DISCUSSION

In this section, we discuss the VA complexity and its themes identified. Furthermore, we reflect on provotyping as design tool in interdisciplinary research projects.

5.1 VA Complexity

This section presents a discussion of the workshop results and subsequent email conversations. The workshop material revealed three themes around the complexity of VAs - here called "complexity themes". They are: *The complexity AI smartness*; *The complexity of forms relationship to cloud computing*; *The complexity of our relationship to our data.* They are discussed in sections 5.1.1, 5.1.2 and 5.1.3 respectively.

What do we mean by complexity? There is no single unified Theory of Complexity, but different disciplines have tried to form theories around complex systems, such as economics [1], social sciences [25] or physics [18]. They all try to understand characteristics of a complex and evolving system. According to Mitleton-Kelly [29] a complexity includes - but may not be limited to the following

Table 2: The twelve provotypes with key workshop responses.

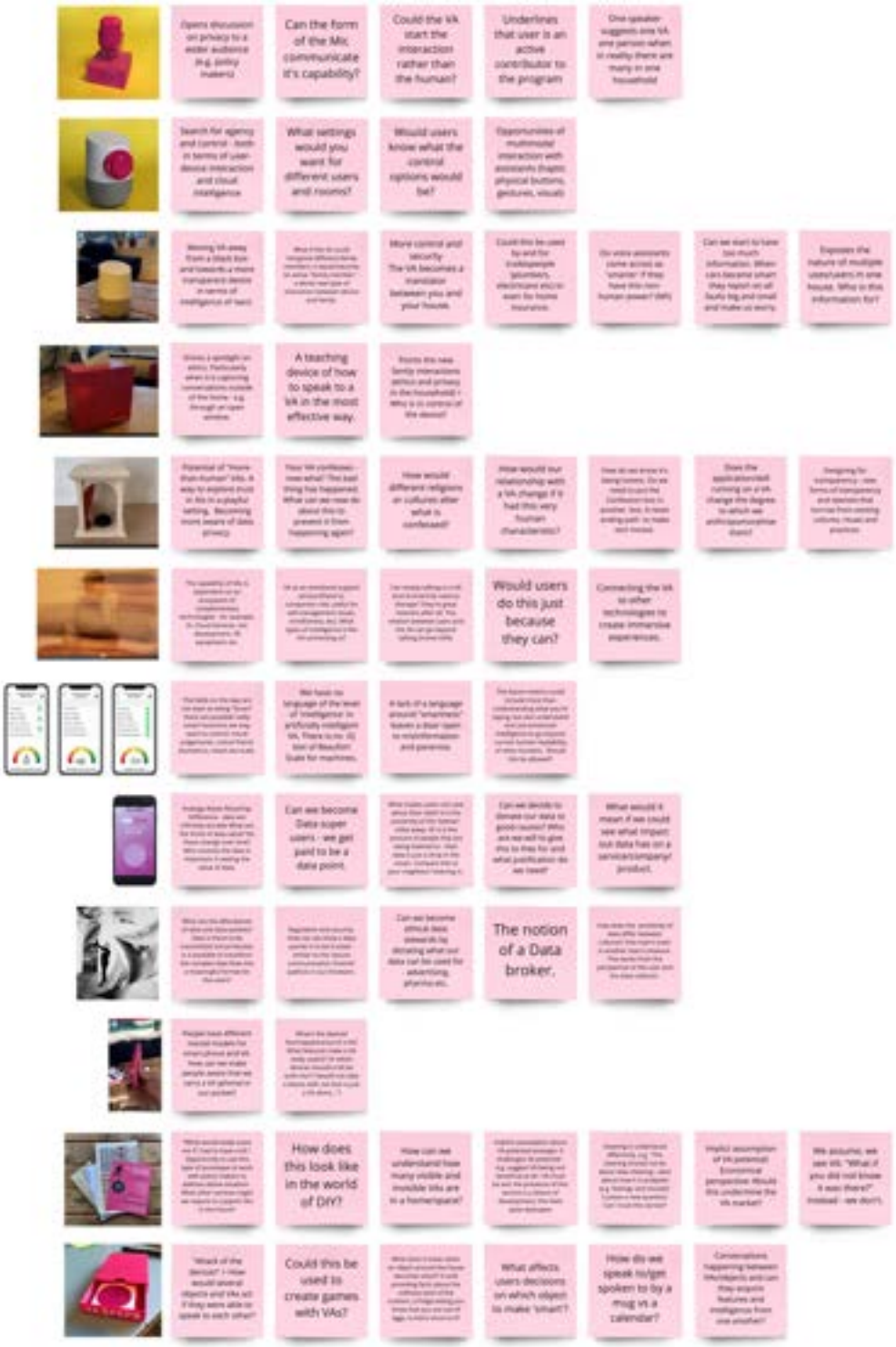

Figure 3: Examining the elephant in the room by isolating and zooming in to different complex elements.

characteristics: Interconnected interaction, interdependence; multi-dimensionality; continuous evolvement; and acting on limited local knowledge without knowing what the system as a whole is doing. In the VA system, connectivity and interdependence can mean that one action by an individual may influence related individuals (member of the family for example) and related systems (e.g., interconnected devices or spaces). Multidimensionality involves separate spheres such as social, technological, economical, legal and cultural that act on/ or influence each other: What on the surface may appear as a technical problem may in fact include social or cultural aspects. Continuously evolving systems is one of the key features of complexity. By this, individual elements act "at random" [25] or within their own logic and continuously reshuffle, what we thought was fixed. They can change the rules of interaction for the users in a way that is difficult to understand or follow. "Acting on limited local knowledge" without knowing what the system is doing describes well what we often see in big organisations - but is also applicable for VA - e.g., individual elements are able to process information or learn independently of the system. The combination of these can make it difficult not only for laypersons, but also experts to understand complex systems or find an answer to emerging problems.

Figure 3 illustrates the three main complexities uncovered during and after the two multidisciplinary provotype workshops: AI Smartness, Form versus Cloud and Data-Relationships. These complexities would have otherwise remained undiscovered without materialising the immaterial and provoking the team. The team often likened this method of probing a complex object similar to the concept illustrated in Figure 3, by isolating and zooming into the details of an unknown thing (the elephant in the room) before we can start to understand the bigger picture, or how the individual elements connect to one another.

5.1.1 Discussion on AI Smartness Complexity. Understanding how intelligent machines are and how we might classify or quantify this intelligence has a long history. The Turing Test established this in 1950 - posing the question "can machines think?". Philip K Dick speculated on how a Turing test might evolve in far futures where the fictional Voight-Kampff test [12] was needed to distinguish humans from machines. Sturdee et al. [38] explore how design fiction *world building* can take a prop out of one story and use it to create entirely new worlds where that prop might exist in new contexts and possibilities. More recently, Stuart Russell [5] has warned that this fiction is rapidly becoming a reality without the checks and measures in place to protect humans from machines. Given that artificially intelligent machines are in our homes, it strikes us as remarkable that we don't yet have the language to do this for ourselves. While Russell talks of a need for an equivalent of an IQ test in machines, we don't fully agree. For end-users there really needs to be something more human-readable and less open to interpretation. A scale like the Beaufort Wind Scale is far more human-readable than an IQ test. It takes measurement (the wind speed) and translates it into everyday lived experience. "The Beaufort scale is an objective scale. It does not measure the speed of the wind but rather the effect the wind has on the environment - predominantly boats at sea [15]. This then feeds into the language for designers. It's easier to design an object for windy situations if you have a language that locates wind speed in your world. A Force 10 tent (as used by the Scottish tent design company Vango), tells you that it can stand up to winds that are "Seldom experienced inland; trees uprooted; considerable structural damage". Like the Force 10 tent we need a scale that can set expectations for the intelligence of a VA.

Internet connected objects, such as phones, tablets and cars are often given the label *smart*. However, this is potentially an ambiguous term, especially when the underlying technology is about providing artificial, machine, intelligence. This is not the same as smartness. Our data shows that smart and intelligent are used interchangeably when discussing VAs - while they describe different things. Smart typically refers to the ability to learn or memorise whereas intelligence is something's inherent ability to think [19]. This masks some of the VAs' characteristics as being the same - while the differentiation between them is critical, when using VAs or developing potential VA use cases. Why is it critical? First of all, the closely related concepts make it difficult to know what interdisciplinary experts refer to, when using the terms. The discussion around these concepts makes clear that the individual concepts are ill-defined. One workshop participant for example commented that what was supposed to represent a smart device, the *Data Flow Customisation provotype (*Figure 4*)*, was "*not smart at all- isn't that what we already have?".* The participant expected something more than not allowing the use of sensible data (such as the IP address, the location or purchasing trends). One participant explains smartness as follows: *"VAs do not understand what I mean! That's about smartness*". This quote is illustrative, because it shows how smartness for this participant is about a VA understanding the user - they expect the VA to contextualise the requests put upon it. The use of multiple personal data flows may be just part of what is needed for VAs to really understand the user. Another, potentially

Figure 4: The Data Flow Customisation provotype

Figure 5: The Super Hearing Provotype

Figure 6: The How the fictional Voight-Kampff Machine may help us understand the intelligence of our VAs. In Blade Runner questions were asked to provoke the interviewee into revealing their true self. In some ways we are provoking our workshop participants to help reveal the intelligence we want from our VAs.

more important part, that is needed here is the algorithm - or AI - "ingesting" [10] the provided data and generating meaning from it. Potential smart features that were mentioned were a button to "switch on moral judgement" - or VA that *"uses all its intelligence and knowledge to sense what you really mean*" or it can be "*a critical friend - to be there when things are tough"* it tells you *"things you might not want to hear.*" This idea of a VA providing too much information and giving the perception of being too 'smart' arose from conversations around the *Super Hearing (*Figure 5*)* provotype. A participant even went as far to label this potential feature as smart due to the fact the VA is doing something humans cannot, "*Do voice assistants come across as 'smarter' if they have this non-human power?*". From this we learn that smartness is about aggregation of data leading to understanding or sensing (ahead) what is needed in a particular situation for an individual person - this differs from participants thinking that smartness relates to the use of personal data. While the first describes a characteristic or power of a device, the latter refers to elements that contribute to this powerful nature.

It became clear that when users want smart things they expect the 'thing' to become smart through customisation or the collection of data, what they really want is the smart 'thing' to have the ability to make better judgments by building context around the requests put upon the technology, which does not necessarily require the collection of personal data. Moving forward, the designers of VAs and their systems should consider users expectations of the 'smart'

Figure 7: The Microphone not Speaker provotype

Figure 8: The VA Everything provotype

things that they decide to integrate into their lives. These designers should start to explore a scale of intelligence, or rather the many different types or dimensions that intelligence can manifest in machines, just as we do for human intelligence.

5.1.2 Discussion on Form/Cloud Complexity. As computational power advances at a tremendous rate, so do its capabilities. It was not that long ago that the physical design of a device determined its functionality. Take for example an old landline telephone. It affords to be picked up, listened to and spoken into. The interface afforded numbers to be pressed. Its form dictated what it could be used for, and more importantly it's capabilities. Now consider a smartphone. Typically a cuboid with a screen and limited physical buttons. Its functionality has not only become vast due to internet connectivity, but also its functionality and capabilities can change at the flick of a switch of a software release or update. The combination of AI and IoT has given devices a "TARDIS" feel, as discussed in the introduction [42]. The complexity between the form of an object and its functionality becomes murky.

Different viewpoints on this relationship emerged during the workshops. It became a fascinating and polarising discussion. Some participants voiced the opinion that when designing VAs we only needed to focus on the cloud services and not the physical form. What is the relationship between the "thing" and the cloud? How does different forms affect the way in which we interact with the cloud, or more so expect the "thing" to act back?

The two provotypes that aided in unpacking this complexity the most were the *Microphone not Speaker* (Figure 7) and *VA Everything* (Figure 8*)* provotypes. The *Microphone not Speaker* provotype explores the idea that a microphone is more representative of what the function of a VA is, but would maybe make users more wary of it as an object in their homes. This provotype helped to unpack the complexity between the relationship between physical form and cloud computing. VAs, as we know them typically exist as physical objects (Amazon Echo, Google Home, smartphones), however the VA intelligence is based in the cloud and the computing happens geographically miles away from the device. A constructive conflict arose within the workshop (and beyond in follow up conversations). One participant stated *"A VA is not mainly characterised by its geometrical shape, aesthetics or its smell."* This is of course true. The computing and the AI elements of a VA typically exist in the cloud, as illustrated by Crawford and Joler's *Anatomy of an AI* [10]. For a human to interact with this cloud service there needs to be a piece of hardware to connect a user's voice to the Internet as a bare minimum, benefit from some sort of feedback - typically sound via a speaker, or visual through a screen or other indicators. Workshop participants suggested that in the future this sort of technology will live in the fabric of our buildings, where others thought there would be a physical device. This led onto discussions of the relationship between the physical form and the cloud, and how this communicates the VAs' affordances of capabilities, privacy and control. Similar conversations arose during the discussions with the *VA Everything* provotype. One workshop participant alluded to the idea of different objects inherently having different levels of smartness "*How do we speak to/get spoken to by a mug vs a calendar?"*. This idea ties directly into the human concept of intelligence - being something we are born with rather than learn. These materialisations of cloud-based computing clearly speak of objects where we find a human connection with, similar to the connections created between the Physical Charts of Taylor et al. and passers-by [39].

The *Microphone not Speaker* provotype unexpectedly caused the most division between the researchers. The conversation was twofold. Immediately a selection of the workshop participants kicked against it as in their opinion the physical form is detached from the VA in that we should be speculating about how to improve the VA system, not the physical product. There were feelings that this was distracting from the real issues the team should be discussing. The other half of the conversation explored how a physical form can emit or even omit the affordances of an object.

This complexity ties in with the previous complexity in a way (AI smartness), and also resonates with Chatting's [9] concept of the need for the *Reappearing Computer* in that we, as designers, should be building VAs where the physical form has the affordances of the VAs functionality, allowing more transparency and control over how we interact with, and the VA interacts with us.

Figure 9: Data Packet Viewer (Creative Commons Image) SilverClouds2.jpg, 2014, By: Sskerchief, CC-BY-SA-3.0

5.1.3 Discussion on Data Relationship Complexity. The privacy paradox suggests that users say that they value their privacy and data highly, but in reality, their behaviours relinquish their privacy and data for very little in exchange or not take the necessary steps to protect their privacy or data. This is no surprise as users are unaware of exactly what data they're giving away or leaving unattended. A lay person's knowledge of such systems is somewhat limited and results in significant understandings [37]. What's valuable data to one person may not be for another. How do we know what we can get in return for our data and privacy? This paradox may well exist due to the unknown-ness of what data is being collected, it's value and how it affects not just the service we receive but other businesses the service provider passes our data on to. Johnson et al. [20] suggest that we relinquish our privacy and data as we become ever more reliant on these AI data collecting machines that are becoming more and more ubiquitous in our lives.

Solove suggests that this paradox is a myth and that "Managing one's privacy is a vast, complex, and never-ending project that does not scale" [19]. Attempts have been made to try and understand the vastness of data collection by smart homes, both within and out with this project [2, 27]. But these attempts only seem to scratch the surface. We can see that data is being collected and sent somewhere, but that's about it.

Data from the workshops underlined the complexity of the affordances of data. It became clear that implications of our data are manyfold and difficult to penetrate by participants. The concept of the value of our data changing depending on your culture, religion, demographic or age kept on bubbling to the surface whilst discussing the data-related provotypes. The notion of donating data also captured the attention of the participants. The final main talking point around our relationship with our data revolved around the implications of providing, or rather, not providing our data.
There were two key provotypes that helped to unpack this complexity. The *Data Packet Viewer* (Figure 9) and the *VA Confessional Box* (Figure 10). The *VA Confessional box* provoked the idea that we could place our VA in a small confessional, just as you would find in Roman Catholic churches. Once in there the VA would then confess its sins. Conversations around the difference in sins between religions occurred with workshop participants asking questions such as *"How do different religions affect the confession?"*. These conversations developed into how different religions would perceive

Figure 10: VA Confessional Box

the value of particular "bits" of their data - and how the value of data changes depending on your culture, religion, demographic or age.
The Data Packet Viewer drew out speculations and questions around the value of our data and how that can change depending on our particular personal values. Here, instead of religious values the workshop participants questioned how this would look in different political landscapes - *"What would this look like in different countries - USA vs China?"*. Taking the perception of value and idea of control of data out with the hands of the user and into the government. The idea of physically holding and inspecting the data packets before they floated to their final destination sparked conversations around control. What would it mean if we could decide what data could leave and what data remained in our homes based on our personal values with one participant stating *"Whose packets do you trust? Apple - Yes, Amazon - No. . . - Highlight packets that go against privacy laws"*, and *"Can you have a say in what you donate your data too?"*. For us to donate our data it implies the participants felt users owned it and it was indeed worth value. The physicality of the provotype may well have led to this feeling of ownership, rather than data as an ethereal element to VAs. Discussions around the implications of users' data followed. For example, speculation upon the repercussions of their data and how this affects the service that they receive. Without the users knowing they could be altering the service they receive or even handing over their data to AI defense organisations. These conversations followed long after the provotype workshop and led to the development of another provotype exploring the butterfly effect of relinquishing what may feel like a trivial data point - such as asking a VA to play a song.
The ability exists to have this transparency when interacting with the world wide web, from inspecting sources of websites to Mozilla's Lightbeam browser extension [17]. Allowing users to see a visualisation of third-party tracking cookies whilst viewing websites. It seems we need a similar device for users to understand the implications of their own interactions with this new wave of listening internet connected devices (Figure 11).

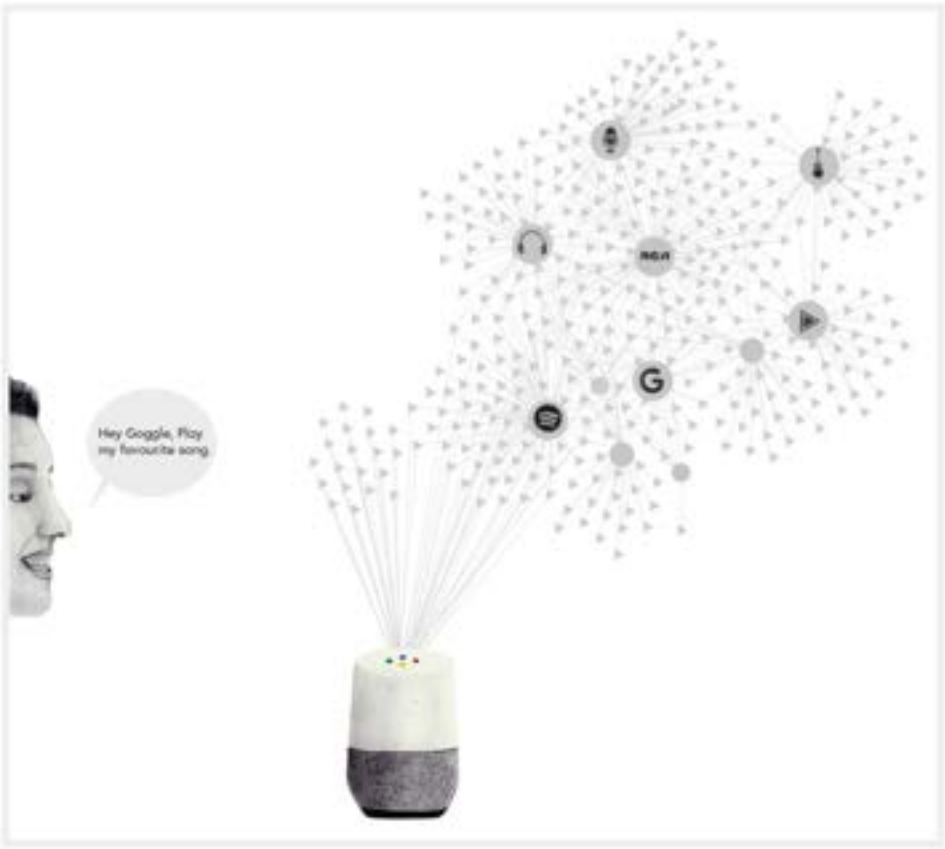

Figure 11: The implications of our data is currently hard to understand and track.

The complexities of the relationship we have with data discussed above highlights some of the pitfalls in the way these AI systems are designed. AI data training sets are typically created with the values and perspectives of a white males, our discussions above suggested that the way in which our data is valued and processed has been determined by the same demographic. As we continue to develop and design these ever increasingly ubiquitous, smart and always-listening devices, we need to consider the values and beliefs of the many, not the few. More importantly, we need to be clear about the implications of what is happening with our data, so that we can align our VAs values with that of our own. If we were able to create this transparency and agency, then the Privacy Paradox may fade into the past.

5.2 Provotyping as a Method

Provotyping was introduced and led by design researchers that were familiar with speculative design and related Research through Design (RtD) [45] approaches. The wider project team were not familiar with RtD or speculative design. Reflecting on the how well the provotypes landed across the project it was clear that the method surfaced a number of tensions across the team. One of the tensions was the nature of the research to define and then respond to clearly defined problems. That the research needed to take a more applied route of identifying problems from a user's perspective, and then finding novel solutions that responded to these problems. We found that by placing provotypes into the research, we were able to start discussions that went outside of this problem-solution space and started to engage the team in "what if" narratives. This was not an easy conversation at times. It was suggested by one of the team members that we did not need provotypes to have these discussions, that we could have just discussed VAs in science fiction. This is true. There are a number of narratives where VAs appear in science fiction – HAL from Kubrick and Clarke's A Space Odyssey turning on its crew [21], the sentient door in Philip K Dick's 1979 novel Ubik refusing to let its owner in [11] or the less sentient voice controlled "computer" in the Star Trek universe [13] are all examples that we can draw on to frame discussions around VAs. However, they frame the discussion from another set of perspectives, perspectives that were constructed from a writer's point of view as part of a wider story or world building purpose. Designing the provotypes in this project enabled the researchers to frame the narrative. Narratives that drew on multiple perspectives that included academic literature, a previous in-home study, project objectives and specific research questions. This is not to say that the provotypes attempted to limit the discussions, it is that they were used to frame discussions to suit the research. In essence by designing provocations in this way, rather than relying on examples

from fiction we were able to specifically control the parts of VAs that we wanted to zoom our discussions into. We had research directorship over the narrative. A role not so different from a film director making editorial decisions to focus on the qualities that make a particular scene in a movie come to life in the way that they want it to. Provotyping is not attempting to conduct clean experiments, as you would perhaps expect from other disciplines, it is trying to generate controlled mess. Mess that we can then later use as part of research that attempts, as RtD does, to embrace the messiness of our life with machines.

6 CONCLUSIONS

VAs are an exaggerated example of bringing together the materiality of a physical product (a microphone and a loudspeaker) and immaterial services (cloud-based AI) into our homes. Yet their materiality is in many ways little more than a conduit. A conduit to vast online services powered by immaterial artificial intelligence. The sum of which is perhaps impossible to fully grasp by any one researcher or any one consumer. By using provotypes with an interdisciplinary academic research team we hope to have provided elements of graspability on the multiple layers of complexities that VAs present to both consumers and researchers in order to strengthen ways in which we can speculate on their future. We have also defined considerations (sections 5.1.1, 5.1.2 and 5.1.3) that the designers of VAs and their systems should acknowledge in order to improve on the human experience of VAs. There remains a clear need for designers of interactive systems to be able to have the design and human language(s) to be able to navigate the future of VAs in ever more trustable and secure, but also playful and meaningful ways.

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