Broadening Exposure to Socio-Political Opinions via a Pushy Smart Home Device

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ABSTRACT

Motivated by the effects of the filter bubble and echo chamber phenomena on social media, we developed a smart home device, Spkr, that unpredictably "pushes" socio-political discussion topics into the home. The device utilised trending Twitter discussions, categorised by their socio-political alignment, to present people with a purposefully assorted range of viewpoints. We deployed Spkr in 10 homes for 28 days with a diverse range of participants and interviewed them about their experiences. Our results show that Spkr presents a novel means of combating selective exposure to socio-political issues, providing participants with identifiably diverse viewpoints. Moreover, Spkr acted as a conversational prompt for discussion within the home, initiating collective processes and engaging those who would not often be involved in political discussions. We demonstrate how smart home assistants can be used as a catalyst for provocation by altering and pluralising political discussions within households.

Author Keywords

Filter bubble; Echo chamber; Selective exposure; Smart home technology; Socio-political discussion; Nolan chart;

CSS Concepts

• **Human-centered computing~Human computer interaction (HCI)**;

INTRODUCTION

Those who believed that the Internet would herald the advent of a diverse digital public sphere have been somewhat disappointed. Through a combination of individual reading choices, highly partisan media outlets, algorithmic curation, social homophily, and other factors, citizens are increasingly likely to encounter political viewpoints with which they already agree [1, 5, 8, 27, 36], though online polarisation is less pronounced than in offline media [31]. Socio-political discussion online is nuanced, and is influenced by a variety of sources, including non-news outlets [51, 66]. Around certain sensitive topics, an overwhelming negative opinion can effectively drown out other, more diverse, viewpoints [13]. Such situations are commonly referred to as echo chambers [25, 33] or filter bubbles [57]. This narrowing of exposure can be highly problematic, as many political theorists argue that exposure to diverse opinions is necessary for a thriving democracy [52].

Prior work has explored ways to combat selective exposure. Examples have included: intentionally injecting oppositional viewpoints into a user's news feed [50]; supporting direct annotation of news articles [67]; explicitly showing users the biases in their own reading history [49]; redesigning the experiences of political news reading [24]; and the deployment of technologies to help structure debate and reflection about news topics [19, 34, 41]. While promising, many of these efforts incorporate a common yet simplistic operationalisation of political diversity; that is, they use a single-dimension to capture the breadth of political viewpoints. This is often represented as a continuum from conservative to liberal, or in some cases from agree to disagree (e.g. [27, 41]). However, some political orientations, such as libertarianism, are difficult to place on such a single-dimensional spectrum. Furthermore, some of these prior design interventions require users to make an active choice in terms of seeking out diverse political opinions. While some work suggests that a minority of citizens are opposed to hearing differing viewpoints, that work also suggests that a minority of citizens will actually seek out viewpoints that conflict with their own [26, 50]

This paper addresses both of these gaps. First, it operationalises diversity of exposure using a Nolan chart [54]. This approach classifies political views according to a two-dimensional space, thereby capturing more nuanced distinctions among different opinions. Doing so offers a richer alternative to the one-dimensional, conservative-liberal approach taken in much prior work. Second, we reconfigure the mode of consumption for online news and opinions by using a *pushy* smart home assistant - *Spkr* (pronounced "speaker") - to interject socio-political topics

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into the home. Smart home assistants have a subservient role within the home, as they are currently designed to 'speak only when spoken to' and will not actively 'push' their voices upon those in the house without being invoked. The voice and audio orientation of these devices, and their place within the home, present an opportunity to insert diverse socio-political topics into discussion.

In this paper we report on a study of *Spkr*, which 'spoke' opinions and views from trending Twitter discussions, to which participants could respond to via the device. To ensure exposure to a diversity of political opinions, we classified our study participants, as well as tweets from these trending topics, according to a Nolan chart. Analysis of interview and usage data demonstrated the effectiveness of Spkr in terms of enabling exposure to diverse political opinions and in encouraging engagement with oppositional viewpoints. The paper contributes new insights to areas of HCI research tackling issues of digital democracy, highlighting the applicability of push-based design strategies in broadening exposure to political opinion. We further reflect on the broader ethical concerns that come from this research, and the associated challenges of implementing such systems in real-world settings in the future.

RELATED WORK

Socio-political discourse online

Online discourse often covers *socio-political* factors, which are common in news articles and opinions that are shared online. Two important phenomena concerning the consumption of news and engagement with opinions have come to prominence in recent years: the *filter bubble* and the *echo chamber*. The filter bubble describes the negative effects of personalisation of digital services, such as news feeds and search engines, within the context of diversity of viewpoints, sources and opinions. Pariser, in coining the term, outlined how such systems place serendipity at risk, and reduces *"coming into contact with* […] *mind-blowing, preconception shattering experiences and ideas"* [57, p.45]. Likewise, an echo chamber is the phenomena where individuals are only exposed to opinions that align with their own. Garimella et al [29] describe the two component parts that form an echo chamber: *"the opinion that is shared, and the 'chamber' that allows the opinion to 'echo'"* [p.913]. In their study to characterise the echo chamber phenomenon, they note an echo chamber is only created by contentious topics, as it is not observed when the topic is not contentious. Furthermore, they highlight latent phenomena within echo chambers that stifle debate: bipartisan users, who are between two sides of a debate, often act as mediators between opinions, but as a result are less central in a community, and receive lower endorsement [29]. As such, Habermas' notion of the *public sphere* [35], that providing access to information leads to a more informed and deliberative democracy, is challenged by filter bubbles and echo chambers. Given that access and availability of information is a basic requirement, it is apparent that the most rational and logical ideas do not rise to the top. It becomes clear that information and opinions that are the most appealing, and therefore easily identifiable by an algorithm as being 'more likeable', rise to the top, facilitated by the technological systems that support socio-political discourse.

Homophily, the tendency for likeminded people to coalesce (described by the proverb *'birds of a feather flock together'* [47]), and selective exposure, are two important factors concerning engagement with opinions. Colleoni et al [15] provide an insightful analysis of political homophily on Twitter, highlighting how the social qualities of the platform facilitate an echo chamber, but the news sharing qualities facilitate a public sphere. Garrett [25] analysed selective exposure to opinions in news articles over a 6-week study with 700 US participants, and found they were *"more likely to look at information that reinforces their opinion"* [p.279] and have a small aversion to opinion-challenging information. They note, however, that users are willing to engage with information that challenges their opinion. Sophr [60] provides an analysis of the interplay between filter bubbles, echo chambers and selective exposure, noting selective exposure plays a major role in the formation of political polarization on Facebook.

The term 'backfire effect' has been used to describe the rejection of oppositional viewpoints and subsequent entrenching of one's own beliefs [55]. However, the effect is debated. Wood and Porter challenge whether it exists, noting that citizens often adhere to facts, even ideologically challenging ones [68]. Exploring the backfire effect on Twitter, Bail et al [3] studied users in the US who self-reported alignment to either the Democratic or Republican parties. Participants were asked to follow a Twitter bot that presented an opposite political viewpoint. Their results demonstrate that exposure resulted in a significant entrenching of views by Republican participants, and some increased entrenching of views for Democratic participants. Similarly, Garimella et al [28] proposed and evaluated a recommender algorithm that exposed opposing views to users around controversial topics. Focused on social media, they describe the 'bridging' of opposing views via sharing (retweets, shares, etc), and their algorithm takes into account the probability of a viewpoint being accepted and subsequently shared. It is also important to consider the motivation for mitigating or removing the filter bubble and echo chamber, as this is dependent on the conception of democracy underpinning it. Bozdag et al [11] detail how an emphasis on deliberation, reflection, and contestation change the perceived effect of the filter bubble, and therefore the proposed remedy. They highlight that filter bubbles are a problem for all conceptions of democracy, but that the means with which to challenge them vary.

Within the HCI community, research has explored ways to reconfigure engagement with news and opinions. Kriplean et al [41] developed a platform to encourage debate around

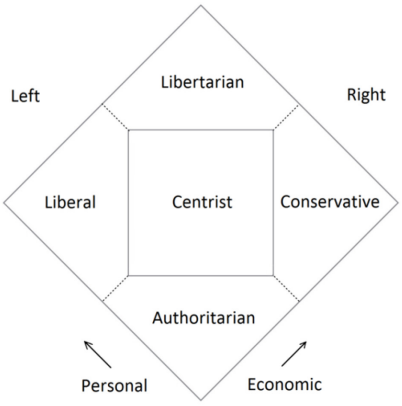

Figure 2. The Nolan chart of political alignment. By Proud User. Licensed under CC BY 0

contentious US state elections. They found, amongst others, that exposure to different opinions led users to incorporate them into their own contributions to the platform. Munson et al [49] found that news readers could be encouraged to consume a more balanced range of news by providing feedback on the political leaning of their reading behaviours over time. In this vein, Wood et al [67] reimagined below-the-line comments on news articles, instead promoting the use of free-hand annotation by users directly on news articles. They found it facilitated user's expressivity directly on the medium, and encouraged debate between users, exposing them to diverse viewpoints on the news articles. Proposing a system to facilitate critical co-reflection on a highly socio-politically charged TV genre, Feltwell et al [24] note that bringing users together into shared space for discourse, framed towards criticality, encouraged debate and discussion about different perspectives.

Smart home technology and socio-political discourse

Previous work has demonstrated that smart home technology can be employed in a variety of ways to bring socio-political, and related, discourses to the fore within the home. The home presents a complex web of social rules and constraints for technology, which it is often forced to operate within. Baillie and Benyon [4] examined the role of digital technologies within the home, and amongst their findings highlight the power struggles between family members over pieces of technology, such as who a shared device belongs to, and the way a device's purpose may have different perceptions amongst the family. More specifically focused on smart home devices, Porcheron et al [58] studied Amazon Echo use in households and found that collective processes across members of a household emerged to control the devices, such as when the device could not understand one household member's commands. Kirman et al [39] approach these social dynamics as an opportunity for the design of smart home technology. They describe an embodied agent, *Nag-baztag*, that uses speech and other visual cues, unprompted by the user, to encourage the household members to conserve energy. Of note, they detail how the device verbally admonishes those who are wasteful of resources, using

Figure 1. The Spkr device

punishments of escalating severity, such as disabling the kettle, or switching off the freeze whilst no-one is home. In this way, we see that *Nag-baztag* uses "pushy" techniques, where even though the user experience can be negative, it is harnessing this pushy behaviour as a powerful means to affect behaviour change.

Along these lines, Gaver et al. [30] describe *EnergyBabble*, an "automated talk-radio" smart home device that broadcast content about energy conservation and the environment into the home. Deployed with communities interested in engaging with energy and environmental based content, the device confounded the participants' expectations, as it did not offer direct advice on energy conservation, but a selection of viewpoints and discourses. The authors posit that devices like EnergyBabble extend the idea of how publics are constructed, presented by DiSalvo [18], by *concentrating* discourses about a specific issue [30, p.1124]. Building on this, Gorkovenko et al [34] evaluated a smart home device to precipitate "second-screen" socio-political discussion around TV content. Connected *Social Printers* were used to create a personal feed for televised political debates. Participants engaged in shared debate by receiving printouts containing questions or prompts, written by other participants and the research team, with a mechanism to contribute their own points. They highlight the way a physical device within the home environment can act as a prompt for conversations and created a community between the users. In these works, we see that smart home devices can facilitate collective processes, and can also be used to interject a range of information into the home and promote related discussion.

POLITICAL ALIGNMENT

In our work, we argue it is of importance to understand the political alignments of both those who use our device as well as that of the socio-political content played by the devices. Our approach to inferring political alignment is based on the Nolan chart [54], seen in Figure 21. This approach provides more nuance than the common, single-dimensional spectrum of conservative vs. progressive or right vs. left. The chart

includes two dimensions of rights. *Social* rights include freedom of expression, personal autonomy, etc. *Economic* rights include the ability to own property, exchange goods and services, etc. These dimensions can vary independently. An individual may strongly support social rights, such as same-sex marriage and abortion, but also oppose granting extensive economic rights, such as free trade agreements or hands-off approaches to market regulation. Such a position would align with a traditional progressive or leftist view. Conversely, an individual may support free trade and market deregulation but oppose abortion and same-sex marriage, which aligns with a traditional conservative or rightist position. An individual who strongly supports both social and economic rights would be classified as libertarian, and an individual who does not support either would be classified as authoritarian or statist. Numerous critiques have been levied against the Nolan chart. It does not originate in scholarly political science analysis but rather was used as a tool to explain simply and succinctly libertarian ideology [20]. The division of social and economic liberties does a poor job of accounting for situations such as prostitution [38]. Finally, David Nolan, its namesake, did not in fact originate the chart [7]. Thus, the Nolan chart may not provide a perfect analytic tool for sorting the diversity of political viewpoints. However, it does provide a useful conceptual lever that we can employ to explore possible alternatives to a single-dimensional political spectrum.

To ensure relevance to our participants, we use a version of the Nolan chart refined for the UK political context by Meek [44]. This provides a mapping of UK politics onto the Nolan chart, and a questionnaire that can be completed to align UK political views with it. We asked participants to complete this questionnaire at the start of the study, furnishing us with political alignment scores for each. Utilising these scores, we tailored content to each participant that both matches their own alignment, as well as an opposite viewpoint. We now detail the design of the Spkr device, and how we operationalised our political alignment as part of the study.

DESIGN OF SPKR

Our work is inspired by adversarial design [19], which encompasses practices focused on provoking engagement with 'the political.' It specifically invokes agonism – the exposure to different ideological perspectives [48], through design. Motivated by the previous work around filter bubbles, echo chambers and selective exposure, we designed a system that re-configured the way these discussions are presented, and subsequently engaged with. Brooker et al. [13] note that socio-political discussions on Twitter can become saturated with one viewpoint, drowning out other diverse viewpoints. Doughty et al. studied this and describe how such one-sided socio-political discussions on Twitter can lead to the disinhibited abuse of groups of people [21]. Twitter also presents a highly active source of discussion, with a range of viewpoints (as used by [24] and [30]). In exploring novel ways to re-configure the engagement with socio-political discussion, our working assumption was that smart home technologies such as Amazon Echo or Google Home provide a potential route to sharing such content in new ways in domestic spaces. Furthermore, their integration of voice user interfaces (VUIs - e.g., Amazon Alexa, Google Voice) provides the ability to respond to such content, allowing interaction to be two-way. To this end, we designed Spkr (Figure 1), a smart home device that is placed in the home and reads out tweets from trending Twitter discussions randomly within pre-defined intervals throughout the day. The content spoken by the device is tailored to each participant based on a political alignment assessment, resulting in the device playing a mixture of content that is based on the participant's political alignment. The result is that Spkr will present the participant with multiple viewpoints from within a trending Twitter discussion.

Operationalising Nolan Chart Political Alignment

Broadly, each day a trending discussion on Twitter would be selected, and the tweets within the discussion manually coded to identify the (socio-) political orientation of each message. Coded tweets are then allocated to Spkr devices, the exact mixture of content dictated by the political alignment of the participant.

Sourcing and Coding of Tweet Content

Topics were selected from Twitter Trending topics, featured Twitter Moments, or by searching for hashtags or topics that were currently in the news. A running list was maintained by the research team of topics in the news that were being discussed on Twitter, with one being selected each day. For logistical reasons, news topics were always selected and coded at a minimum of one day before participants would hear them. The criteria for selection of a topic were: i) a news item within the last 5 days, ii) focus on a socio-political issue or topic, iii) there is a large volume of tweets specifically about the topic (e.g. 50+), and iv) there was evidence of multiple viewpoints on the topic within these tweets.

Once a topic was chosen, tweets were coded to a quadrant of the Nolan chart, representing the political alignment of the views expressed within the tweet. This was performed by a single primary researcher, to ensure consistency. The research team developed descriptions of the stance on socio-political issues of each quadrant, derived from Meek's model, to guide the coding. An abridged example: "Liberal – against free market capitalism, pro individual liberty". In order to code tweets, the primary researcher used the quadrant descriptions and Meek's political alignment questionnaire to assess which quadrant the tweet aligned to most. Any tweets that were difficult to align were given a *best guess* coding. At the end of each coding session, the research team examined all tweets and alignments, discussing any best guess coding, to come to a consensus. Tweets from news organisations that did not present an overt opinion or view on the topic were used to populate the neutral category. The team worked on a per-day basis, collecting all tweets for one study day before moving onto the next. An example of coded tweets can be seen in Table 1.

Allocating Coded Tweets

The mixture of content received was based on the political alignment of the participant (see Table 2). For example, a participant aligned to Liberal would receive 40% Liberal, 40% Conservative and 20% Centrist content. The tweets within each quadrant represent diverse range of viewpoints, which are thusly spoken through the device. Our rationale for drawing content from the opposite quadrant of the Nolan chart was to provide an identifiable contrast to content from their own quadrant. In practice, this varied based on the tweets about a topic, and could be, using the previous example, 20% Conservative and 20% Libertarian, rather than 40% Conservative. This results from the natural variation in the viewpoints expressed on Twitter. Furthermore, we are cognisant of Munson and Resnick [50] who describe the tolerance of disagreeable news and opinion users will withstand. Therefore, we provide 40% of the content aligned to their view, along with a "neutral" Centrist 20%, to maintain a balance. Through experimental testing, 20% Centrist (neutral) content was also necessary to orient the listener somewhat to the topic being discussed. For the purposes of this study, those participants classified as Centrist were classified to their nearest quadrant, as following experimental testing, Centrist tweets could easily be perceived as one, two, or even three of the adjacent quadrants, and thus the mixture of viewpoints was not clear.

Implementation

Spkr is composed of an Amazon Echo smart home assistant, seated on a small wooden base, containing a Raspberry Pi computer. We chose to use the Amazon Echo within our device as it provides suitable audio functionality to play spoken content into the home. Echo also provides suitable voice recognition and conversational interface tools for use in our device to support responses from participants. The Raspberry Pi uses Bluetooth to transmit audio to the Echo. The Raspberry Pi connects to our server via Wi-Fi and retrieves voice audio to be played. On our server, we store text-to-speech audio, generated by a voice synthesis API provided by CereProc [14]. The mixture of audio content played by each Spkr is dictated by the server each day. Tweet content was manually input by the research team into a database, consisting of tweet text, political category, and the study day it was intended to be spoken. Automated scripts collated playlists of content for each user for each day of the study. The research team used a custom web interface to edit and refine voice audio, to ensure correct pronunciation. We experimentally defined the settings and voice accent used for the text-to-speech, consulting with a linguist in our research lab, who helped us define a voice that would be distinct from the Alexa voice used in the Amazon Echo. This resulted in a southern Scottish-accented voice, which is geographically close to Newcastle upon Tyne, UK. Prior to each piece of audio content, a short notification chime would sound, followed by a 5 second pause.

Responses to Spkr content were facilitated using an Alexa Skill, a software routine specific to Amazon Echo, created by the research team. In order to respond to any content they have heard, participants were required to say *"Alexa open speaker feedback",* which would then prompt them with *"What do you think about what you just heard?"* Their following response was then recorded and stored on the Amazon servers, accessible by the research team.

Cat.	Example Tweet
Liberal	The race to the bottom with airlines started with Ryanair, abusing passengers. Putting passengers first would be a winner
Libert.	Remaining in the EU couldn't have saved Fly BMI, I don't think. Passenger numbers were not sustainable. Political gain by blaming Brexit, maybe?
Author.	Talking of Fly BMI, our local economy depends on Flybe. Big employer and connects us with parts of UK and Europe.
Conserv.	Derry airport will hardly survive, following the loss of Fly BMI. When people think of NI they think of the backstop and border. But losing them will be huge for us.
Neutral / Centrist	UK Regional airline Fly BMI has announced it is filing for administration and has cancelled all flights.

Table 1. Example categorisation of tweets for 'collapse of Fly BMI airline' topic, anonymised via rewording

Through the design of Spkr we sought to provide a sense of unpredictability. Spkr was designed to operate within up to three timeslots each day, nominated by the participant, and it would play content randomly at any point within each timeslot. Following testing by the research team, we decided 10 tweets per day in total would be feasible. Drawing inspiration from qualities of radio, we did not provide any replay functionality. In this way we capitalise on the ephemeral nature of oral communication, - that speech is physically felt by the listener, demands attention, and that the crafting of statements effects how memorable they are [56].

STUDY DESIGN

Spkr was evaluated as part of a four-week long study with 10 participants. The device was installed in participants' homes, playing content across 28 days. A single participant was recruited from each household. Participants were inducted into the study in their own homes, where a 20-30 minute semi-structured interview was performed to establish existing news consumption habits and experience with smart home technology. Participants nominated up to three time slots during the day where they were likely to be in the house and would be willing to engage with the device (see Table 2). Following this, a Spkr device was set up in their living space, in a place of their choosing. They were informed the device would read out opinions from Twitter, and that they could respond if they wished. The day after the device was installed Spkr began playing content within the nominated times. This continued each day for the duration of the study.

On the third day of the study, a member of the research team contacted the participant to ensure the device was working correctly and that the nominated time slots were suitable, modifying them if required. At the mid-point of the study (day 14), participants were again contacted by the research team to ensure all was working ok. After 28 days, Spkr stopped playing content, and the research team visited participant homes to conclude the study. This took the form of packing up Spkr and performing a 30-45 minute semi-structured exit interview, which explored their experiences, and the topics they heard and their responses. A full debrief followed this. Participants were given £60 in high-street vouchers, broken into a £10 voucher a commencement of the study, and the remaining £50 voucher at the end of the study. One Spkr device (P9) encountered a persistent hardware issue until it was changed on day 14.

Participants

Ten participants were recruited for the Spkr study, who were drawn from the local population in Newcastle upon Tyne, UK. Participants were sourced by a professional participant recruiter to ensure a diverse range of participants. 5 identified as female, and 5 identified as male, with ages in a range from late 20s to late 60s (see Table 2). In order to maintain the smooth functioning of the study we specified the following criteria during recruitment: i) must not have an Amazon Echo or Google Home within the house, and ii) must not be away from home for more than 5 days for duration of the study. To accommodate for the vagaries of family life, we set 5 days as the maximum participants could be away from home. We did this as we were not expecting participants to hear everything spoken by Spkr, nor did we want participants to force themselves to stay at home or in the room to listen out for Spkr, as we felt this would not be a natural engagement with the system. None of the participants were known to the research team, nor had any previously had an Amazon Echo in their home. All were aware of what an Amazon Echo was, with approximately half of the participants having used one at a relative or friend's house. During recruitment there was no specification that participants should be interested in news or politics, which resulted in a diverse range of engagement with news during daily life. One participant [P9] engaged very little with news, only listening to news bulletins on the radio, whereas others (e.g. [P8]) avidly consumed news through smartphone apps, TV, and radio, as well as actively seeking out discussions at work and with family members. All participants are referred to by their anonymised number (Px) and researchers as R.

DATA ANALYSIS

Inductive thematic analysis was performed on the entrance and exit interview data, following the process described Braun and Clarke [12]. Two researchers familiarised themselves with the interview transcripts. The primary researcher then produced a codebook from an initial coding of around half of the transcripts. Both researchers then discussed the codebook, identifying duplicates and clarifying meanings. The primary researcher then performed complete coding on the full set of transcripts. Both researchers then clustered the codes into subthemes and themes.

RESULTS

Over the course of the 28-day study, a variety of topics were presented by Spkr, predominantly UK political topics, such as Brexit, business, and crime stories. World politics was also featured, such as the US-Mexico wall and the Venezuelan border crisis. In terms of the location of Spkr in participant homes, six participants had it in a lounge area (P1, 2, 3, 4, 5, 10), with the remainder having it in their kitchen. Participants contributed their responses to Spkr with varying levels of engagement, as can be seen in Table 2. P6, 8 and 10 responded to a large quantity of what they heard. This took the form of short *"I agree"* or *"I don't know"* statements, to more considered responses: *"Absolute fabrication, 'cos I work for a Latin American company, they pay good wages, health care, and doing right for me and my family"* [P8]. These three participants were almost always in the room at the nominated timeslot, and thus followed the content and responded to much of it. Other participants did not respond to the device at all and had low levels of engagement. P5, a police officer, did not feel comfortable sharing their opinion, but described that they heard a lot of the content. P3 had Spkr operate all day, and as they would be performing odd jobs, watching TV or in the garden throughout the day, they would listen and respond whenever they were nearby the device. Another group of participants (P7, 9, 2) were keen to engage with the device, but found themselves often out of the room, which was attributed to shift work (P2) or a busy lifestyle (P9). During the course of the study, the Spkr devices

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Profession	Nurse	Taxi Driver	Delivery Driver	Police Officer	Teacher	N/a	Admin.	Logistics	Admin.	N/a
Time slot(s)	Morn., Eve.	Eve.	All Day	Morn., Eve.	Morn., Eve.	Morn., Eve.	Morn., Eve.	Morn., Eve.	Eve.	Eve.
Alignment	Auth.	Auth.	Liberal	Auth.	Liberal	Liberal	Liberal	Liberal	Liberal	Liberal
Resp / day	0.28	2.03	1.21	0	0	1.82	0.64	5.32	0.96	3.17
Responses	8	57	34	0	0	51	18	149	27	89

Table 2. Participant information and Spkr alignment data

delivered 494 broadcasts to participants and received 433 responses to messages across all participants.

We now present the results of our thematic analysis, organised into four themes.

Spkr's effect on how news is consumed

While it was not in our recruitment criteria, all but one of our participants reported being habitual consumers of news. Common news media such as television (morning or evening news broadcasts and 24 hour rolling news), news websites and smartphone news apps were used variously and habitually by participants. Opinions from social media already formed part of the news consumption process of some participants, with Facebook and Twitter being the primary platforms. Two participants (P7 and P8) stated they also used Snapchat as a source for news, consuming content from news organisations: "*It's everything from Sky News to the Daily Mail to The Sun, it's a bit of everything under one app.*" [P8]. Our one exception was P4, who noted he and his family: *"Kind of live in our own little bubble, to be honest with you. We're happy we keep to ourselves, kind of thing.*" [P4]. Furthermore, very few of our participants noted they would engage in sharing opinions of news stories or comment on them online, although several reported being interested in the opinions shared by others online on news stories: *"I do read* [comments] *though, always interested to see what people are saying around the issue."* [P2].

Participants noted that during the study their news consumption practices had changed or been adapted to include Spkr. For some, Spkr had become a reliable source for the news, to the extent that they did not feel it necessary to use their usual sources: *"I might have even checked the news less, to be honest, knowing that at eight o'clock I was going to get filled in with the top stories of the day."* [P2]. Others noted it had increased their interest in news: "*100% listening to more news in the car rather than music. I don't know whether it was just total coincidence or I subconsciously thought, "There's more stuff going on out there, let's have a look and see what's happening." Put the news channel on."* [P4]. With others it encouraged them to engage with news and discussion in ways they hadn't before: *"I've been involved in a couple of discussions at work as well, when normally I would ignore them."* [P7]. In P7's case, news stories that they considered they would not normally have been aware of were brought to their attention. Other participants presented similar views, appreciating the diversity of news stories that Spkr would bring to them: "*I think random* [news stories] *is good because I wouldn't like to say, 'I want to know this, this and this'. I think having current news, I think that's a good thing because some things you totally miss in the news."* [P9]; and *"It was pretty good what was chosen. There were a couple of things that went over my head, but overall I enjoyed listening to what came through."* [P6]. In P6's case, this often triggered a process of further research:

"I did look up a lot more to think I want to know myself more about that. I don't often get the chance to have things brought to light […] *It was good for bringing different opinions to your attention to make you question actually am I right in thinking that"* [P6].

At the same time, some participants stated they would prefer to pick the topics themselves, to include more relevant topics, for example: "*It didn't know what I liked. If I typed in my football club or 'price of diesel' or 'war in Syria' or 'Jewish history', then that would be important to me, therefore the tweets would be tailored."* [P5]. Of course, in many respects this was missing the purpose of Spkr, which was to purposely challenge the notion of being recommended news stories aligned to predisposed preferences.

Precipitating reflection upon, and criticality of, news

Many participants reported that they already employed a degree of criticality in their news consumption practices. Sometimes this was based on the perceived trustworthiness or rigour of certain sources of news: *"The Guardian, and the Independent, they've got hopefully more intelligent people with a more balanced view there, but not always."* [P2]. Others reported trying to interpret stories to identify bias, albeit quite what this was as a process was hard for them to articulate: *"I try to work things out in my head of actually what is going on. What are they telling you?* […] *How much is it propaganda"* [P3]. However, not all of our participants exercised critical practices when consuming news: "*I never think what specific news channels will sway me to go a different way.* […] *I'm probably really naïve to think that that's it, that's news and it's right*" [P9].

Over the course of the study, participants reported that Spkr triggered various reflective processes based on broadcast content. This included inquiring more about a story, ruminating on their own viewpoints, or triggering a discussion. P9 described how a topic about Malcolm X caused them to research the topic, and reflect on their own knowledge of history:

"they were saying that he was more extreme than the extremists […] *I had just Googled it, it said that he had been assassinated and I was just like, 'This is really quite sad that I don't know about this historical thing'"* [P9]

All of the participants were aware of contrasting or alternating viewpoints being presented within Spkr's content: *"some topics, like, they were put across and then I felt like the next question was put across in a different way, if that makes sense? Same topic, different way"* [P8]. Others mentioned how this diversity triggered reflection on their own viewpoint: *"It was good for bringing different opinions to your attention to make you question actually am I right in thinking that."* [P6], and *"it gets you thinking about the issues so it kind of straightens your opinion out in your head a little bit"* [P2]. Being presented with diverse viewpoints led to changes in opinion for some of the participants, as discussed by P10: *"It was quite refreshing because, there*

was one day I found I was in agreement with it, and then they said something, and I thought, 'Yeah, you're right', and it made me give comments the other way on it." [P10]. P9 described how the different viewpoints were persuasive: *"if it wasn't something I fully understood I would be listening to it* [...] *and then I would listen to somebody else's side of view and think, 'Oh, I never really thought of it like that'"* [P9]. Both P9 and P10 mentioned they would ask a family member about a story: *"I wasn't 100%, so on certain things I would have to ask my husband what he knew about it"* [P9].

Considering the political alignment and coding that was conducted on the content used in the study, it is interesting to note that some participants felt the content was biased on certain topics, likely reflecting the types of topics discussed on Twitter [45]: *"I think it was more left wing, yes, definitely.* […] *like obesity, and the immigrants were mostly focused on"* [P7]. The source of the tweets was also discussed, so they could establish whether to trust it as a source: "*If I knew the background of who it had come from* […] *I would understand, well, they've said that because of this, or they are of this background, that makes sense why they would think that way, but they are thinking that way because of that directly impacts them."* [P7]. This highlights a tension, as providing the source of a tweet could both help a listener understand the context the statement was made in, but also to introduce their own biases into this process.

Raising domestic political debate

A defining feature of Spkr was that it broadcast material within participants homes, and thus had the potential to raise socio-political topics for discussion in a domestic space. All of our participants lived with other people - their spouses, partners, children - and in many cases the times when participants requested Spkr to broadcast content were those times when more than one householder was present. Because of this we saw examples where Spkr acted as a communal object, which, due to its speaking nature, drew in those in the vicinity. P6 reported that Spkr activated: "*Usually* [at] *breakfast time, clearing up, in the mornings with the little one. And usually at night time, six to seven, it's teatime so we're quite often sitting at the table and my partner would be back by then and it would come on*." P7 similarly noted the presence of multiple people, and in particular her young niece and nephews, in the home when Spkr broadcast news: *"I would be conscious as to what I was then listening to and what they were taking from it. I would think that I would need to be having conversations with them, topics that would be putting questions in their mind from hearing them."* [P7]. P9 had a different opinion of the suitability of the content:

"*There was not anything I felt wary about for my daughter or anything like that. Like even today we were in the car and the radio was on and it was on about the guy from Ted Baker resigning because he was having young girls sitting on his knee* […] *She's questioning that kind of thing because actually she should question that kind of thing, and that she's actually listened to it and paid attention"* [P9].

The presence of Spkr in the home, and its loud broadcasting of news, often led to householders in the vicinity to share their opinion with those around them: *"It was quite interesting because* [my husband] *would then start getting involved because, obviously, he comes in at just before the six o'clock started so he would be like, "Wow" and we sat and actually discussed things between us two, which we never really do these days"* [P6]. Moreover, in some instances, members of the household would direct the participants how to respond: *"He would say: "She said something about this, this and this so just say this, this and this"*, which was not without pushback from the participant: "*I says, 'Look, I'll say what I want to say' […] we're so different, what he was telling me to say"* [P10].

Participants explained that the contexts and communal settings within which Spkr broadcast was not always well received. P8 noted that Spkr had a habit of interrupting conversations between family members, which inevitably ended up with her focusing attention on the device over her loved ones: *"Because I was trying to concentrate on what it was saying I was telling them to shush.* […] *R: How did that go? P8: With my partner, not good at times. 'I'm talking to you!'"* [P8]. In other instances, Spkr started to cross boundaries over what may be considered acceptable discussion points in the home. While many of the participants reported that they would discuss the news and *"talk it through"* [P2] in the home, there were clear ideas of what topics to avoid in the house: *"we kind of have the same opinions and we'll tend not to talk about politics and religion and stuff like that"* [P4]. Spkr regularly challenges these divided lines between what was and was not acceptable to talk about in participants homes.

Appreciating and making sense of Spkr

Overall, throughout the study participants generally responded well to the main feature and principles of Spkr. Several participants noted the ephemerality of the spoken content afforded the device with an ability to command attention: "*When that's actually speaking to you, then it gets your attention more, I think, because it did stop me in my track, it did make me turn around and listen to what was being said."* [P7]. The lack of a repeat function lent the content a scarcity that encouraged participants not to miss it, such as rushing into the room: *"if you're through the back and you're washing dishes, or the washing machine or you're in the bathroom, it's trying to get back down in time again to catch the rest of it"* [P1]. In some cases, participants reported some frustration and upset with missing content, and rushing to the device to ensure they would not miss a broadcast as it aired: "*if you're through the back and you're washing dishes, or the washing machine or you're in the bathroom, it's trying to get back down in time again to catch the rest of it"* [P1], and *"Sometimes I was upstairs in the bath and I could hear it and I'd think, 'Oh, bugger, I've missed it'"* [P10]. In some cases participants reported turning the volume of the device as high as possible to ensure they could hear it throughout their home, and meant they avoided

having to *"just sit and wait for it to go"* [P1]. The ephemeral nature of Spkr was seen as both a strength and limitation of the device, it was clear it drove participants to engage, and to feel as though they were missing out on important material when they were unable to get to the device.

The synthesised voice used for the device also required participants to listen carefully. Several of the participant reported problems with the intelligibility of the voice, often struggling with the specific accent we had chosen: *"Then obviously being robotic as well, Scottish-robotic was a little bit tricky, a little bit thick of an accent."* [P2]. However, it was also noted how the use of a voice, especially one that required some concentration to understand, focused attention to Spkr when it was broadcasting content:

"*It's easy to just put something else on the TV, but when that's actually speaking to you, then it gets your attention more, I think, because it did stop me in my track, it did make me turn around and listen to what was being said."* [P7]

Furthermore, P8 demonstrated that listening to opinions through a voice interface led to all the opinions being merged into a single persona, which they found occasionally jarring: "*Sometimes she said phrases, like she'd say something about Donald Trump and then she'd say, 'Yeah, go Donald Trump!' like that was her opinion, like she thought it was right"* [P8]. We see the participants attributed some kind of persona to the device, which was then confounded by the opinions that would be spoken through the device, and how it seemingly contradicted itself.

DISCUSSION

In this paper, we have reported on the deployment of a pushy smart home device, Spkr, as a means to understand how to broaden political exposure. To do this we used political classification in order to represent identifiably diverse viewpoints. In our discussion, we draw out insights related to the ways pushy smart home devices have the potential to broaden people's exposure to socio-political opinions and the ways they might facilitate widened awareness of and engagement with diverse viewpoints on newsworthy topics.

Broadening Exposure and Questioning Relevance

Prior research has noted that people often engage in their own critical processes when it comes to seeking news from different organisations or platforms [25]. This was also the case for many of our participants, whom were quite aware that different media outlets would spin news in certain ways, and that they might speak to distinct audiences and readerships. To a degree however letting such criticality shape choices over where to find out about and discuss news stories reduces opportunities to find out about and be confronted with alternative viewpoints on a specific issue. Our participants reactions to Spkr demonstrated how this was, for most of them, a novel experience. Indeed, in some cases we saw how they were able to identify, based on the content of different broadcasts associated with similar news stories, the positions being taken and how they related to their own. In some instances, hearing the diversity of perspectives made participants question *"am I right in thinking that?"* [P6]. In their work on promoting user-generated annotations of news stories, Wood et al. observed the ways that seeing news stories from multiple perspectives, and the reactions of other anonymous readers to these, users learn more about their own opinions [67]. Similarly, we saw how Spkr content was used as a sounding board for one's own opinions, at times reinforcing views, but also promoting in some deeper reflection on why they held a specific view on a topic. Our use of political alignment to present viewpoints on a topic and projecting those through a device in the home aligns with Gaver et al.'s [30] principle of *concentrating* the varied discourses around an issue into a single space. It therefore creates an opportunity for reflective *inquiry* [6], as opinions from different viewpoints to one's own are spoken into their home, and potentially confront and challenge their viewpoint, irrespective of their engagement with the device.

At the same time, we also saw how some participants wanted content explicitly personalised to them, as they were not interested in some topics, such as US politics, and stated they had no relevance to their life. As already noted in the findings, the position of these participants was at odds with the design principles of Spkr – the whole purpose of the system was to challenge individuals to have broader awareness of diverse news stories and, in particular, alternate socio-political opinions to their own. This point highlights a tension between giving a user topics in which they are interested, and presenting topics that are contentiously debated, ideologically diverse, but seemingly less relevant. Put differently, filtering based on a user's preferences may inadvertently exclude contentious but important topics outside the user's interests [62]. Work is ongoing with recommender systems to reduce this tension, such as Garimella [28] who propose an algorithm for exposing users to related viewpoints. Pariser [57] describes how filter bubbles threaten to remove serendipity from the news consumption process. Here, we posit that a pushy smart home device reintroduces a degree of serendipity into the news consumption process, by pushing socio-political topics that may be minor news items in mainstream news outlets but are being actively discussed online. Serendipity presents opportunities for the design of systems when considered as a value in itself, even if this is challenging for users [40].

Promoting Engagement with News and Opinion

It was also clear that Spkr triggered a process of further research for many of the participants. For some this was driven by their interest in a topic. However the qualities of the system - the lack of context that often came with a broadcast, and the occasional inability to interpret a position on an issue Spkr had broadcast - fed practices of seeking more details about stories. We also saw that for some participants Spkr became, at least temporarily, a regular source of news. Despite Spkr's focus on a single topic per day, several participants detailed they came to rely on it as

their key source of news, as they knew it would be active at certain times of the day, such as when they got home. While this is somewhat problematic in that the single-story per day focus of Spkr may in fact reduce awareness of news overall, it presents one solution to the "*news-finds-me"* attitude, where users do not actively follow the news, but expect the platforms they use to expose them to all relevant and important news [32].

The pushy nature of Spkr was also a powerful way to attract the attention of those around it, and to widen engagement with socio-political topics across a whole household. This was particularly effective when leveraging the household rhythm, such as during meal times, or when members of the house congregate. Spkr broadcasts were shown to initiate debate, which in some households, as P6 described, *"we never really do these days"*. This points to the ability for pushy smart home devices to entangle others in the room in a conversation about topics that would not normally emerge. In one case, as detailed by P10, this even took the form of another member of the house directing the participant what they should say, which they recounted, created some tension. Collective control of technology in the home and the subsequent power dynamics that develop around ownership and control have been explored [4], and the household rhythm is a rich, often unique situation in each home for a device to operate within [10, 43]. Dickinson et al. [17] demonstrate how external factors such as employment and family arrangements largely define it, and thus influence the way media is consumed within the house. Predicting an appropriate time, within each unique rhythm, for interruption from a pushy device could be addressed in future work, e.g., using machine learning, engaging the household in discussion using the VUI, or using externally scheduled events such as TV programmes, as was done by [34].

The Power of Smart Home Devices

A quality of Spkr was the power it seemed to have over our participants during the study. The ephemeral nature of each piece of spoken content was instrumental in creating a sense of urgency among those in the home, as they knew there was no way to repeat what was being said, and might miss a particular viewpoint. This afforded the device more power within the household, as it caused participants to come running, to shush those around them, or to feel as though they had missed out on something important if elsewhere. Porcheron et al [58] note how smart home assistants often enact power over a situation, for example when being invoked, and this was also the case for Spkr. As noted by Xu et al. [69], ephemerality of content shapes the interaction of its users. Without a repeat functionality, it dictates that users listen to it, on its own schedule, even if they would not like to engage with it. Our study shows that pushy smart home devices are a powerful way to attract the attention of, and initiate discussion with, those in the household.

However, it is easy to see how such a technique could result in detrimental experiences, and deeply unethical practices, through certain types of use. As Kirman et al. [39] highlight, pushy devices can be used to enforce, or reinforce, specific behaviours and 'desirable' attitudes within the home. In applications dealing with socio-political content, those who control the design and functionality of smart home device (e.g. the developers) are in a position of power to manipulate the framing or sourcing of the content, which would facilitate explicit and implicit bias, as in agenda practices of news editors [46]. Given the sensitivity of some socio-political topics, this could severely impact the democratic process or further the stigmatisation of vulnerable groups. We did not encounter any identifiable misinformation throughout this study, but future work must be cognisant of the systemic nature of disinformation campaigns [61]. Given the potential for different voice user interfaces to be seen as more trusting than others based on their vocal qualities [63], such devices could be seen as a route to broadcasting specific political views into people's homes and shaping householders socio-political opinions. Furthermore, in requesting responses from households to news content, the devices could feasibly become 'political sensors', used as a means to gather political opinion. Such practices would, of course, be potentially highly problematic.

Limitations of our approach

This work involves substantial labour in the coding process, and familiarisation to Meek's UK-centric model. This limitation could be addressed via automated classification, as well as drawing upon other political models that might classify content differently (e.g. the US centric Nolan chart [54]). We also take a specific view on ideological diversity (agonism [48]), but opportunities exist to build interventions that serve other models of democratic debate (e.g. deliberative, contestatory) [11].

CONCLUSION

We have reported on the design and deployment of a smart-home device, Spkr, that used pushy characteristics to interject a diversity of opinions and viewpoints into the home. Our results show that injecting socio-political topics into a home entangled those in the room, initiating debate and discussion, where it was previously absent. Through adopting the two-dimensional Nolan chart, we presented listeners with a diverse range of views, often outside their habitual news consumption, precipitating further research from participants about news stories. We contribute an understanding of how pushy smart home devices can fit into the complex social household environment, demanding attention, and promoting engagement and reflection on opinions and viewpoints.

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