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'Alexa, what do you mean to me?': a scoping review and model of parasocial relationship formation with smart speakers

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ABSTRACT

This scoping review evaluates the literature on the social aspects of smart speaker use, with a focus on how parasocial relationships form and their outcomes. A key contribution of this review is the proposal of a 'Parasocial Relationship Spectrum', which classifies the types of relationships users develop with smart speakers. Additionally, we establish isolation and older age as predictors of parasocial relationships with smart speakers, while identifying emotional comfort and reduced loneliness as key outcomes.

A major gap in existing research is the lack of long-term, targeted studies on the full range of effects from smart speaker-based interventions, particularly in vulnerable populations. To address this, we integrate findings from parasocial and human–computer interaction research to propose a novel framework – the ASAP Pathway (Anthropomorphic – Social Agent – Parasocial) – as a mechanism explaining how users develop parasocial relationships with smart speakers. This framework offers a structured approach to further studying interactions with smart speakers and their outcomes.

Finally, we emphasise the need for future research to refine and validate the ASAP Pathway, ensuring that smart speaker-based social interventions maximise benefits while minimising risks. By doing so, this review provides theoretical advancements and practical implications for implementing smart speakers in social and therapeutic contexts.

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Parasocial; smart speaker; social technology; loneliness; human-computer interaction; anthropomorphic

1. Introduction

1.1. Smart speakers

Smart speakers are internet-enabled, speech-controlled, interactive smart devices, such as Amazon Echo or Google Home. These devices are designed to automate and streamline everyday tasks with assistive services (e.g. setting alarms and reminders) and access to multimedia and online information (Han and Yang 2018). Their functional repertoire can be enhanced through add-on applications (sometimes called 'Skills' or 'Actions') which unlock a wide range of additional features from remote calling to guided meditation (Amazon 2021). Smart speakers use voice-recognition software and online natural language processing servers. This allows the user to control the smart speaker by conversing with the brand-specific virtual agent (e.g. Alexa is the virtual agent for Amazon Echo smart speakers) (Han and Yang 2018). For many, the purchase of a smart speaker represents the first introduction of 'human-like' artificial intelligence into the home environment.

Since their launch in 2014, over 205 million smart speakers have been sold worldwide (Business Wire 2020). This success is frequently attributed to the conversational interface of smart speakers which offers enhanced accessibility and a unique social capacity. Additionally, smart speakers have a highly anthropomorphic design (e.g. having a name, a human-like voice, offering humorous remarks, etc.) and conversational interface, facilitating interactions with the contained virtual agent that feel natural and intuitive (Ki, Cho, and Lee 2020). Smart speakers are often considered to be more accessible than other smart devices because they are generally lower in cost and can be navigated purely by spoken commands. For individuals who struggle to navigate visual-interface devices or are at risk of digital exclusion (e.g. due to lower digital skills (Blocker et al. 2020) or physical (Jamwal et al. 2020), cognitive (Smith et al. 2020), or sensory impairments (Abdolrahmani et al. 2020)) smart speakers offer an accessible option for digital engagementintuitive (Ki, Cho, and Lee 2020).

The presence of smart speakers reflects the emergence of a new era in human–computer interactions (HCI); we no longer use technology simply as a method to communicate with other people, rather, we aim to

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communicate with the technology itself (Voit et al. 2020). Further, the increasing success and ubiquity of smart speakers incites a need to understand this shift from a psychosocial perspective, considering why social interactions with smart speakers are becoming so common and what the outcomes of these interactions are. Relevant theories and paradigms relating to the social value of smart speakers will be examined below.

1.2. Anthropomorphism

Anthropomorphic design is pivotal to the success of smart speakers (Cao, Hu, and Xu 2022; Wu et al. 2019). Anthropomorphism is the tendency to assign human traits and characteristics to non-humans, for example, ascribing motivations, emotions, or intentions to non-human animals or objects (Epley, Waytz, and Cacioppo 2007; Nass and Moon 2000). This could involve perceiving a happy face in a cloud formation or assigning a complex emotive or cognitive narrative to a pet (Nass and Moon 2000). However, anthropomorphism is not invariantly applied to all non-humans in our environment, with Epley's Thee-Factor Theory (Epley, Waytz, and Cacioppo 2007) of Anthropomorphism suggesting that triggered prior knowledge (elicited agent knowledge), the human need to understand our environment (effectance motivation), and the innate drive for social connection (sociality motivation) all influence anthropomorphic perception.

Anthropomorphic principles are frequently harnessed in design to promote user engagement. The goal of anthropomorphic design is to create an object that triggers widely-held schemata about positive social traits, leading to the attribution of these traits to the designed object (Aggarwal and Mcgill 2007; Schweitzer et al. 2019). For example, car grilles and lights may be designed to appear as smiling faces if the designers wish for happy, positive attributes to be associated with the car (Schweitzer et al. 2019). This becomes more relevant and complex, however, when considering socially capable technology such as artificially intelligent agents or robots. When anthropomorphic design is successfully achieved and social schemata are triggered, users can begin to perceive these devices as possessing some human-like qualities.

This is exemplified by the design of smart speakers; possessing a name, a human-like voice, and a gendered persona supports the illusion of an anthropomorphic entity. Gao et al. (2018) and Chung and Woo (2020) both conclude that users' frequent attribution of human she/her pronouns constitutes anthropomorphic activations and underpins the linguistic theory of ontological categorisation; mindlessly assigning human-like pronouns to smart speakers self-fulfils to deepen the perception of smart speakers as human-like, furthering the anthropomorphic attributions (Voit et al. 2020; Pradhan, Findlater, and Lazar 2019).

1.3. Computers are social actors (CASA) paradigm

The anthropomorphic design of technology can indicate social potential (Gambino, Fox, and Ratan 2020). As technology ceaselessly progresses, we see an increase in the social cues and affordances that can be demonstrated to users, leading to a heightened perception of social potential (Fox and McEwan 2017). Representing this, the Computers are Social Actors (CASA) paradigm suggests that humans mindlessly produce social behaviour in response to computers that activate our social schemata (Reeves and Nass 1996). Perception of a computer as a social actor commonly leads to users adhering to social norms, such as politeness, when interacting with the computer (Nass, Steuer, and Tauber 1994; Jones et al. 2021), and preferring socially capable actors over non-social computers (Lee et al. 2012; Baxter et al. 2017; Fogg and Nass 1997; Gong 2008).

Smart speakers meet both criteria required to be viewed as socially capable actors: they present sufficient social cues and are an independent social source (rather than only transmitting social information from other sources) (Voit et al. 2020). This perception of smart speakers as social actors is evidenced by users' presentation of mindless, overlearned social behaviours, such as saying 'thank you' or 'good morning', despite conscious awareness that they are unnecessary or inappropriate (Pradhan, Findlater, and Lazar 2019); users subconsciously perceive the smart speaker to be a social actor and so are mindlessly applying social scripts and norms and when interacting with them. Individuals who live alone are most likely to perceive their smart speaker as a social actor, likely arising from the increased sociality motivation9.

1.4. Parasocial relationships

Repeated interactions with a social agent can lead to a parasocial relationship. Parasocial relationships originally described the phenomenon of perceived social relationships and an illusion of intimacy with television personalities (Horton and Wohl 1956) among some viewers. Parasocial relationships have similarities with human-human interactions in that they can be deeply socially gratifying but are distinct in that they are unidirectional and non-reciprocal.

Parasocial relationships have occasionally been documented with smart speakers, underpinned by their prosocial design features (Wienrich et al. 2023). Users report feeling a sense of friendship with and even love for their smart speaker (Oh, Chung, and Ju 2020; Cho, Lee, and Lee 2019), reflecting a parasocial illusion of intimacy (Horton and Wohl 1956). Further, despite evidence that users converse similarly with their smart speaker as with other humans (e.g. with a sense of rapport (Cerekovic, Aran, and Gatica-Perez 2017)), the interactions are non-reciprocal as the virtual agents within smart speakers cannot incite conversations or express human-like features such as emotions, wants or thoughts. For these reasons, users' relationships with smart speakers can be classified as parasocial.

1.5. Current scenario

To date, there exists a large body of HCI research focussing on understanding why people interact with socially capable technology, and what the implications of these interactions are. This has led to findings that humans can form relationships with embodied conversational agents that are similar to human-human relationships in terms of self-disclosure, feelings of warmth, and shared ideas (Loveys et al. 2022). Further, the emotional expressions of socially capable technology, such as empathy and emotional understanding, are particularly important for encouraging users to engage socially (Ling et al. 2021). Often this research has been conducted with devices whose main purpose is to mimic human-like relationships or to provide some kind of social value.

Comparatively less research has focused on the parasocial potential of smart speakers, possibly because they are primarily designed as virtual assistants, and not to intentionally provide social value. However, for many people, they represent the first introduction of human-like artificial intelligence into their homes and are now extremely common (present in over 65% of US homes (Laricchia 2022) and 50% of UK homes (Federica 2023)). Therefore, if only a small percentage of people form parasocial relationships with their smart speakers, the absolute numbers may still be substantial because the user target is so vast.

Research on smart speakers tends to focus on functional interactions, such as mapping feature use (Furini et al. 2020), barriers to adoption (Wallace and Morris 2018), and privacy concerns (Cha et al. 2019). Despite their clear social capabilities, far less research has considered the psychosocial implications of repeated interactions with this socially capable, artificial intelligence. Of the research that does consider this, there is a lack of consensus regarding the methods and measures used to understand this topic and a lack of synthesis of the resultant findings.

For these reasons, the present study aims to systematically review the current literature on social aspects of smart speaker use. A particular focus is placed on the outcomes and implications of relationships formed with their smart speakers, the factors influencing these relationships, and the methods used to gather these findings. As such, we propose three research questions:

RQ1: What outcomes arise from forming a relationship with a smart speaker?

RQ2: What user attributes have been reported in association with forming relationships with smart speakers?

RQ3: What methodological approaches have been used to research relationship development with smart speakers? What are the merits and drawbacks of these approaches?

2. Materials and methods

2.1. Protocol

A scoping review method was used to produce a systematic and comprehensive overview of this unmapped research topic (Arksey and O'Malley 2005). This method was the most appropriate due to the exploratory research questions, lack of prior synthesis on the topic, and active research being produced in this area (Colquhoun et al. 2014). The protocol for this scoping review was established prior to commencement and followed the PRISMA guidelines for scoping reviews (Page et al. 2021). Additionally, the five-stage process for conducting scoping reviews, outlined by Arksey and O'Malley (Arksey and O'Malley 2005) and summarised below, was followed:

1. Identifying the research question while maintaining sufficient breadth to ensure coverage of the topic.
2. Identifying relevant studies through effective search strings and online databases.
3. Study selection based on specific inclusion and exclusion criteria.
4. Charting the data by summarising key features of all included studies.
5. Collating summarising, and reporting the results by presenting numerical and thematic analysis.

2.2. Sources of information

A search was conducted on the 2nd of February 2024 to identify literature relating to relationships with smart speakers. The following databases were searched due to their coverage of technology and social science topics: Association of Computing Machinery (ACM), Association

for Information Systems (AIS), Institute of Electrical and Electronics Engineers (IEEE), Science Direct, Scopus, and Web of Science. Search terms involved synonyms for smart speakers and named examples of brand-specific smart speakers with the requirement that companionship, socialising, or similar also be mentioned (See Appendix for the specific search strings used).

2.3. Study identification

Inclusion of literature in this review was limited to those that met the following criteria:

1. Studies published between the 1st of November 2014 the date when the first smart speaker was released to the open market (Mutchler 2017) and the 2nd of February 2024.
2. Studies that report empirical data reflecting users' relationships with or social value derived from their smart speaker. This excludes papers that are exclusively theoretical or methodological, don't relate to smart speakers, or don't discuss users' relationships or social interactions with a smart speaker.
3. Studies published in English

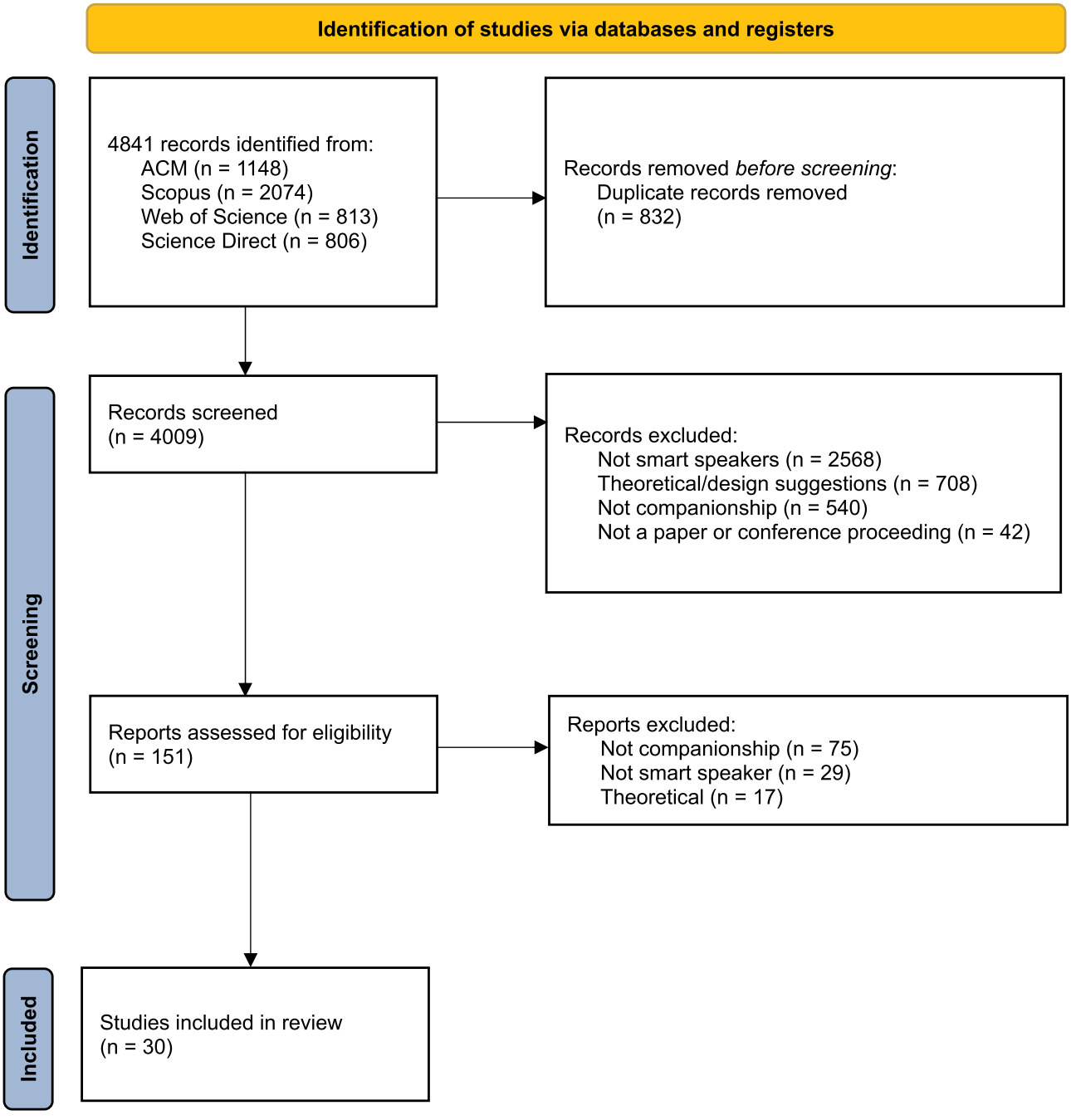

Figure 1. Study selection process based on PRISMA guidelines for scoping reviews (Page et al. 2021).

Table 1. Summary of the 30 papers included in this scoping review.

Author(s)	Aims/Research questions	Sample characteristics	Measures	Period of device use	Devices used	Social value reported
Blocker, Kadylak, and Rogers (2023)	To understand how older adults use their smart speakers over time, what challenges they face as first-time users, and what instructional materials are useful for supporting adoption and engagement.	7 older adults (aged 61-79) with limited/no experience of smart speakers. 4 males.	Semi-structured, monthly, phone interviews, established measures (e.g. Telephone Interview for Cognitive Status (Fong et al. 2009), UCLA Loneliness short-form (Russell 1996), TechSAge Background Questionnaire (Remillard et al. 2020), and adapted measures (e.g. The Alexa Companionship Measure adapted from Cotten, Anderson, and McCullough (2013))	Fourth months	Amazon Echo Show 5	Consistent anthropomorphisation of their Echo Show (e.g. she/her pronouns). Reporting a sense of companionship and feeling less lonely from their interactions. Two reported Alexa as a friend.
Brause and Blank (2020)	Aimed to investigate how smart speakers are used and become meaningful to users.	12 self-described technologically proficient individuals	Semi-structured interviews (15-90 minutes).	Not reported.	Varied.	Participants viewed their smart speaker as a companion, with some talking to it to combat loneliness. This was particularly valuable for individuals living alone.
Cao, Hu, and Xu (2022)	To test the hypothesis that cognitive and affective anthropomorphism of smart speakers will satisfy users' social motivation.	551 smart speaker users from China, mostly below age 35. 64% male, all with experience of smart speakers.	An online questionnaire consisting of adapted items, including the intention to explore smart speakers, social connection with a smart speaker, and affective and cognitive anthropomorphism.	6–12 months was the most common, but specific times were not reported.	Popular devices in China, such as Xiaoaitongxue by Xiaomi, Tmall Genie by Alibaba, and Duer by Baidu.	Anthropomorphism of smart speakers positively influences user perception of social value and connection, possibly because anthropomorphism fosters feelings of familiarity that underpin positive social perception.
Cha et al. (2019)	1) Are the roles of conversational agents different in the multiple-device contexts compared to single device contexts? 2) 2) If so, how do users interact with them differently?	9 heavy smart speaker users (≥ 3 connected smart devices and > 5 interactions per week.) All males living in South Korea, aged 34–46 ($M_{age} = 42$).	Semi-structured interviews (up to 2 hours).	Average of 10 months prior to the study.	Not reported.	19% felt their smart speaker was a companion, and felt supported by the social greetings provided, particularly in the absence of household members. Smart speakers were labelled as family guardian, butler, or intimate friend.
Chambers (2020)	How can Amazon Alexa be used to support patients?	30 UK patients with health or dependence needs and no experience of smart speakers.	Follow-up phone surveys.	Minimum of two months during the study.	Amazon Echo Show.	Users living alone/who were alone for most of their day found that having a smart speaker to talk to was comforting and it offered companionship to combat their loneliness. Some reported feelings of embarrassment around this social connection.
Cho, Lee, and Lee (2019)	To understand how people use smart speakers in their daily lives and explore the associated obstacles or difficulties.	8 new smart speaker users in South Korea. All fluent or proficient in English. Half of the sample lived alone. Participants were aged 28–52 ($M_{age} = 31$), equal gender representation.	Diary studies posting on private social media, surveys and interviews were conducted. Usage logs from the smart speakers were also collected.	Participants used their smart speaker for 12 weeks as part of the study.	Amazon Echo's in conjunction with Phillips Hue smart bulbs and Brunt Plug smart plugs.	Some participants describe their Amazon Echo as a 'kind friend' and something to play with.
Choi and Choi (2023)		292 smart speaker users. 57% female. Age 18–63 ($M_{age} =$	Existing items from previous studies (e.g. Park et al. (2018), Hughes	Minimum of 1 month of usage	Not reported.	Lonely individuals were inclined to continue using their smart speaker

(*Continued*)

Table 1. Continued.

Author(s)	Aims/Research questions	Sample characteristics	Measures	Period of device use	Devices used	Social value reported
	To investigate the relationship between social loneliness and intention to use smart speakers.	24.17). 1/3rd had a smart speaker for over a year, 2/3rds used it daily.	et al. (1999)) were administered through an online survey.	prior to the survey.		because they found it attractive as a conversational partner.
Choi and Drumwright (2021)	1) What are the primary motivations for using a smart speaker? 2) What is the association between motivations, attitudes, satisfaction, and intentions to continue using a smart speaker? 3) What is the association between motivation and perception of smart speakers' social attraction 4) What is the association between motivations and perceptions of the role of a smart speaker as (a) a friend, (b) an assistant, and (c) technology?	256 participants from the U.S.A. aged 17–38 (M_{age} = 21.5). 218 lived alone. 96 males.	Questionnaire measures were designed for this study to test users' motivations.	70% had used the device for over 3 months prior to the study.	70% used Amazon smart speakers, 25% used Google. 5% used either Samsung, Apple, or Microsoft.	Desire for social interaction was the strongest predictor of all motivations modelled for using smart speakers. Additionally, the more socially motivated users were, the more likely they were to perceive the smart speaker as a socially attractive, friend-like entity.
Corbett et al. (2021)	Aimed to describe smart speaker use and usefulness from the perspective of older adults and their support persons.	10 participants from the U.S.A., aged over 70 years old (M_{age} = 75) with at least two chronic conditions. 8 of the older adults lived alone. 1 male.	Baseline measures of health and wellbeing were taken. The support person gave a measure of Caregiver Burden. After 60 days, an interview was conducted.	60 days during the study.	The older adults received an Echo Show and Echo Dot, support persons also received a Dot.	Participants report anthropomorphising their smart speaker, viewing it as 'another person', and feeling a sense of companionship from its presence.
Duque et al. (2021)	To discuss how older people view the automated content delivery and personalities of smart speakers.	33 older adults aged 75–93 across 23 households in Australia. 9 participants lived alone, the rest lived with partners or family. 14 males.	Interviews were conducted at 2, 8 weeks, and 4 months.	4 months over the course of the study.	Each home had one large Google Home and 2–3 Google Minis. After 3 months, Google Nest Hub Max's were added to 12 houses.	Some participants anthropomorphised their devices, showed mindless social behaviour (e.g. being polite), and quickly perceived companionship. Companionship was thought to be particularly beneficial for lonely or isolated individuals.
Gao et al. (2018)	To analyse how the personification of smart speakers correlates with the emotional expressions in product reviews.	55502 reviews. No demographic information was gathered or reported.	Verified reviews from Amazon Echo's Amazon listing were extracted and analysed for their content.	Not reported.	Amazon Echo	Over 500 reviews report Alexa as being a 'good friend' to talk to, with a further 345 viewing it as a family member. A few report a closer relationship (e.g. a girlfriend, mistress, or wife).
Han and Yang (2018)	1) Do users have a social relationship with their smart speakers? 2) Does a social relationship affect user satisfaction? 3) How can the formation of a relationship be improved to increase satisfaction and ensure continuance intention?	304 participants with experience of using a smart speaker. 63% male, aged 18-50.	An online survey was distributed through Amazons Mechanical Turk. Measurement items were developed from a range of previous research.	Not reported.	Not reported.	Satisfaction and continuance intention can be predicted by parasocial relationships and social attraction, reflecting the social benefit and drive experienced by users.

(*Continued*)

Table 1. Continued.

Author(s)	Aims/Research questions	Sample characteristics	Measures	Period of device use	Devices used	Social value reported
Jang (2020)	Does smart speaker users' parasocial interactions, personification type, and loneliness influence their satisfaction?	534 Korean smart speaker users aged 20–40 (M_{age} = 34.8), 315 males.	Parasocial interaction, loneliness personification type and satisfaction were assessed using measures adapted from a range of previous studies.	Not reported.	Not reported.	Parasocial interactions positively influence satisfaction with smart speakers, suggesting that stronger perception of the smart speaker as a social entity is associated with more satisfying interactions.
Jones et al. (2021)	To explore the influence of a smart speaker on loneliness reduction among aging adults 75 + living alone, and the role of anthropomorphic interaction with AI.	16 older adults aged 77–96 (M_{age} = 85) living alone in an independent living facility in the Midwestern US. All showed normative cognitive functioning. 5 males.	Interaction logs from the Amazon Echos were accessed by researchers. Number of interactions were assessed, partially to ensure that participants were achieving the minimum 5 interactions per day. Content of the interactions were also assessed using thematic analysis. Loneliness was assessed using UCLA loneliness scale (Russell 1996) at baseline, 4, and 8 weeks. Participants computer and app usage prior to the study was assessed on a 4-point scale at baseline.	8 weeks during the study.	Amazon Echo.	Regular use of a smart speaker over 4 weeks was found to be beneficial for reducing loneliness. Baseline loneliness was a strong predictor of initially friendly interactions with the smart speaker, perceiving it as human-like, and finding companionship from it.
Ki, Cho, and Lee (2020)	To examine the mechanism with which users develop para-friendships with smart speakers.	335 participants from the U.S.A. were recruited through Amazon's Mechanical Turk.	Measurements (e.g. intimacy, self-disclosure, social support, stickiness intention, social isolation) were adapted from existing scales.	Not reported.	Amazon Alexa (specific device not specified).	Parasocial perceptions of friendships influence users continuance intention. Further, self-disclosure and perception of social support are key to developing parasocial relationships.
Kim and Choudhury (2021)	To explore how older adults perceive and use a smart speaker as they move from novice to experienced users.	9 Adults living alone in senior accommodation in New York. No prior experience of smart speakers, but some experience of computers. Ages 65–95 (M_{age} = 83.8). 3 participants used a wheelchair. 5 males.	Interaction logs were downloaded from the devices to be thematically analysed and coded for operation type (e.g. playing music).	16 weeks during the study.	Google Home mini.	Mindless social behaviour (e.g. saying 'please' or 'thank you') were present from the first use. With repeated use, this developed into digital companionship, having 'someone' to talk to, reducing isolation and loneliness, and receiving emotional support.
Liu, Wang, and Hu (2023)	To explore older adults' propensity to adopt smart speakers in line with the Technology Acceptance Model (Marangunić and Granić 2015).	425 older adults (age 60+) living in China. 51% female.	Online and paper surveys were administered comprised of a collection of multi-item scales from previous research (e.g. Pal and Arpnikanondt (2021), Song, Yang, and Cheng (2022)).	Ranging from no prior experience to over 3 years of experience prior to the study.	Not reported.	Perceived companionship was the strongest predictor of usage intention.
Ma and Huo (2024)	To explore how personality influences the perception of companionship from smart speakers.	460 participants. 61% female. 75% aged 18–34 years.	Questionnaire survey comprising items adapted from existing research (e.g. from Lee and Kwon (2013), Yang, Lee, and Zo (2017); John and Srivastava (1999)).	Not reported.	Not reported.	Extraverted and conscientious personalities were more likely to view smart speakers as socially attractive, leading to companionship. Agreeable individuals were less likely to view smart speakers as companions.
				Not reported.	Amazon Echo.	

(*Continued*)

Table 1. Continued.

Author(s)	Aims/Research questions	Sample characteristics	Measures	Period of device use	Devices used	Social value reported
McLean and Osei-Frimpong (2019)	To understand the variables influencing smart speaker use in the home.	724 UK participants, aged 18-64, 326 males. Largely experienced with technology.	An online survey consisting of adapted items (e.g. relating to utilitarian, hedonic, and symbolic benefits, social attractiveness) from existing measures. A new scale for social presence was developed.			Social attraction (perceiving the smart speaker as friend-like or something to enjoy spending time with) was a significant predictor of smart speaker use.
O'Brien et al. (2020)	To explore how older adults and caregivers utilise smart speakers.	125 reviews. No demographic information was reported.	Reviews were thematically analysed.	Not reported.	Amazon Echo.	Companionship was a major theme. Users reported reduced isolation, perceiving the device as a companion, and enjoying having 'someone' to talk to.
O'Brien et al. (2022)	To understand how smart speakers can be leveraged to reduce loneliness and social isolation among home-bound older adults.	11 geriatric experts (over age 21) and 5 patients (over age 65), all based in the U.S.A.	Feedback from participants was qualitatively analysed to identify themes.	4 weeks during the study.	Google Home.	Companionship was a major theme; hearing their smart speakers' voice in the home can be comforting and reduces feelings of isolation.
Oh, Chung, and Ju (2020)	Aimed to investigate the differences in usage and perception of smart speakers between old and young users.	19 participants were divided into 'old' (>50, $n = 12$, $M_{age} = 61$) and 'young' (<50, $n = 7$, $M_{age} = 36$) groups. 7 lived alone. 8 males. Conducted in South Korea.	Interaction logs were analysed into categories (e.g. music/audio). Semi-structured interviews were conducted after 14-days and were inductively thematically analysed.	14 days during the study.	Clova.	Repeated interactions lead to great perception of Clova as a social presence, resulting in half of the participants viewing it as a conversational partner and deriving comfort from their interactions.
Park and Kim (2022)	This study aimed to evaluate the efficacy of smart speakers in reducing loneliness and depression among older adults.	291 South Korean adults aged over 65 ($M_{age} = 77$) with no prior experience of smart speakers. 74% were women. 76% were receiving government financial benefits. 36% had more than one disability.	Frequency of smart speaker use grouped participants into 'frequent' or 'intermittent. Depression', loneliness, physical functioning was all assessed using a questionnaire containing established measures.	2 months during the study.	NUGU candle.	Loneliness and depression levels reduced significantly after frequent interaction with a smart speaker. Conversely, smart speaker use was higher amongst those with a high baseline rating of loneliness.
Pitardi and Marriott (2021)	To investigate the drivers of consumers' trust and attitudes towards smart speakers in relation to parasocial relationship theory.	466 UK adults with at least some experience of using smart speakers. 60% male, aged 18-65.	An online questionnaire consisting of adapted items (e.g. usefulness, ease of use, enjoyment, social presence, social cognition, privacy, trust, attitude). 12 of the original sample completed a semi-structure interview.	Not reported.	Not reported for study 1. For study 2, all participants used multiple voice assistants: All used Amazon Alexa and 8 used Google Home.	Perceiving the smart speaker as a social presence is associated with increased trust of the device.
Pradhan, Findlater, and Lazar (2019)	1) To understand how older adults categorise smart speakers. 2) To make design recommendations. 3) To discuss personification in relation to anthropomorphism and ontological categorisation theories.	7 adults in the U.S.A. aged 65–83 ($M_{age} = 72$), with low technology use. 6 lived alone. 5 lived in senior living communities and 2 lived at home. 1 male.	Semi-structured interviews were conducted at weekly and at baseline. Interaction logs and daily diary entries were gathered. The data was analysed using a constructivist grounded theory approach.	3 weeks.	Amazon Echo Dot.	Users show adherence to social norms of politeness, such as saying 'please' or 'thank you', indicating perception of a social entity and mindlessly employment of social schema. Some described Alexa as a 'friend'/'phantom friend'.

(*Continued*)

Table 1. Continued.

Author(s)	Aims/Research questions	Sample characteristics	Measures	Period of device use	Devices used	Social value reported
Scherr, Meier, and Cihan (2020)	To understand how to increase the participation of elderly people in social activities and reduce loneliness with the help of digital solutions, specifically using Amazon Echo Shows.	11 German adults aged 68–86 (M_{age} = 76). 10 of the participants lived alone. 3 males. Participants had no experience with smart speakers.	Baseline interview covering participants background, attitudes towards technology, and expectations. Further trimonthly interviews. 'Café parties' were used as informal focus groups at 2 and 5 months. Exit interviews were conducted. Usage logs were extracted covering the entire project period.	18 months over the course of the study.	Amazon Echo Show.	Participants reported that they enjoyed using their smart speaker and felt less alone as a result.
Shao and Kwon (2021)	1) What are the primary motivations for smart speaker usage? 2) How are different motivation factors related to satisfaction with smart speakers? 3) Does social presence interact with motivation factors to predict satisfaction?	247 smart speaker owners were recruited through Amazons Mechanical Turk, aged 25-34. 82% had a university education, 70% male.	An online survey of adapted items relating to motivation and social presence. The data was then analysed using factor analysis.	Not reported.	Not reported.	Smart speakers' social perception is a significant predictor of users' satisfaction, suggesting that smart speaker's success is driven by their social interactivity.
Smith et al. (2020)	To assess the outcomes of providing mainstream smart speakers to individuals with ID via a semi-randomized controlled trial using a mixed methods approach	48 controls and 42 intervention participants living in supported accommodation in the U.K., aged 22-82. All had mild to moderate intellectual disability and conditions such as autism or Down syndrome.	Interviews were conducted at baseline and 12 weeks to measure agency and wellbeing. Staff were also surveyed relating to their perception of participants smart speaker use.	12 weeks over the course of the study.	Amazon Echo and Google Home.	Social value emerged as a prominent theme from the qualitative analysis, with participants perceiving their smart speaker as a social companion.
Wu et al. (2019)	How do people perceive smart speakers considering their low-anthropomorphism appearance but high-anthropomorphism voice interaction capabilities?	418 internet users in China, all smart speaker users. 53% male.	An online questionnaire gathered quantitative data about smart device usage, preferences for relationships with smart devices, and perception of existing technology. Two focus group interviews were also conducted (n = 14).	Not reported.	Not reported.	27% of the sample perceived their smart speaker as a friend, 10% as a companion/partner, and 9% as a sibling. All of these roles reflect a perception of social value.
Yan, Johnson, and Jones (2024)	To investigate whether extended smart speaker usage (4 weeks) would effectively reduce loneliness for older adults and understand the pathway of this potential influence.	15 older adults (75+), all living alone and recruited through independent living facilities. No experience of smart speakers.	In-person administration of the UCLA loneliness scale (Russell 1996) on day 1 and day 28. Interaction logs with the Amazon Alexa were analysed.	56 days	Amazon Echo	The more participants interacted with their smart speaker, the greater their reduction in loneliness. It is suggested that more time spent interacting fosters comfort and familiarity, which underpin the reductions in loneliness.

The initial search yielded 4841 records, which were reduced to a sample of 151 following title and abstract screening, and a final sample of 30 following full-text screening using the above criteria (see Figure 1 for full details).

The 30 records included in this review were coded for extrinsic characteristics (e.g. authors) and methodology (e.g. samples, measures) in the below table (see Table 1).

3. Results

Across the literature on smart speakers, there is an overarching theme of their novelty being tied to their anthropomorphic design and social presence. This seems to be particularly driven by their voice-controlled interface (Ki, Cho, and Lee 2020) and conversational capabilities (Pradhan, Findlater, and Lazar 2019). This theme is highlighted and explored by this review; frequent interactions with this anthropomorphic technology in users' homes lead to many perceiving smart speakers as social agents, and some developing a parasocial relationship or experiencing companionship. However, this is not a universal finding. As with human-human interactions and relationships, there is a great diversity in the formation and classification of human-smart speaker relationships. Here, we review the factors noted in the literature as influencing these relationships, the outcomes of such relationships, and the methods used to explore this topic.

3.1. RQ1 What outcomes arise from forming a relationship with a smart speaker?

4 themes emerged to reflect the breadth of outcomes arising from parasocial relationships formed with a smart speaker reported in the literature. These themes, and associated subthemes, are shown in Figure 2 and discussed in more detail below.

3.1.1. Relationship classification

24 of the 30 papers reviewed discussed the way users classified their relationships with their smart speakers, despite none setting out to do so. From this sample of 30 papers, 5 distinct Relationship Classifications were ascribed to smart speakers in order of decreasing frequency: Companion ($n = 15$), Friend ($n = 9$), Quasi-Other ($n = 6$), Assistant ($n = 6$), and Lover ($n = 3$) (see Figure 3 for a visual representation of these frequencies).

'Companion' was the most common classification ($n = 15$) (Smith et al. 2020; Wu et al. 2019; Pradhan, Findlater, and Lazar 2019; Jones et al. 2021; Oh, Chung, and Ju 2020; Cha et al. 2019; Corbett et al. 2021; Kim and Choudhury 2021; Blocker, Kadylak, and Rogers 2023; O'Brien et al. 2022; O'Brien et al. 2020; Brause and Blank 2020; Chambers 2020; Duque et al. 2021; Ma and Huo 2024) and reflected a positive, valuable social relationship (Cha et al. 2019) which was cultivated through repeated interactions with the smart speaker (Corbett et al. 2021; Kim and Choudhury 2021). Smart speakers viewed as companions were capable of providing social and emotional support (Cha et al. 2019; Kim and Choudhury 2021). Companionship also reflects the routines that individuals have developed with their smart speakers, reflecting this consistent social presence in the home. For example, users report that 'at night I always tell her goodnight … I always report in every morning' (Corbett et al. 2021). Users who reported isolation or lacking social interaction in other aspects of their lives were more likely to define their smart speaker as a companion (Pradhan, Findlater, and Lazar 2019), possibly because this loneliness acts as a motivator for social engagement (Epley, Waytz, and Cacioppo 2007) and drives users to purchase and engage with their smart speaker (O'Brien et al. 2020; Shao and Kwon 2021). Highlighting this and reflecting the perception of intimacy that is characteristic of parasocial relationships, one user reports 'rarely feeling alone, but if I got a little lonesome, I can ask her some stuff and she's here. It's as if she knows me' (Blocker, Kadylak, and Rogers 2023).

'Friend' was the second most common classification ($n = 9$) (Ki, Cho, and Lee 2020; Wu et al. 2019; Gao et al. 2018; Pradhan, Findlater, and Lazar 2019; Cho, Lee, and Lee 2019; Blocker, Kadylak, and Rogers 2023; Ma and Huo 2024; Choi and Drumwright 2021; Scherr, Meier, and Cihan 2020). Many participants perceive their smart speaker as a friendly social presence, saying 'Alexa is my friend' (Cho, Lee, and Lee 2019) and 'Alexa is a kind friend' (Cho, Lee, and Lee 2019). Similarly, users who feel their smart speaker is a friend maintain a characteristic illusion of intimacy, highlighted by a participant who feels more comfortable expressing vulnerability to their smart speaker than their friends; 'I don't want everybody to know that I don't know something, but I don't mind Alexa. She seems like my friend' (Blocker, Kadylak, and Rogers 2023). This perception of friendship is underpinned by the voice interface, which allows users to feel they are conversing naturally and socially with the device (Pradhan, Findlater, and Lazar 2019; Cho, Lee, and Lee 2019). Despite users classifying the relationship with their smart speaker as a friendship, implying bidirectionality to the underlying social and emotional investment, the presence of only one human in this relationship means it is ultimately parasocial. This highlights the strength of the social

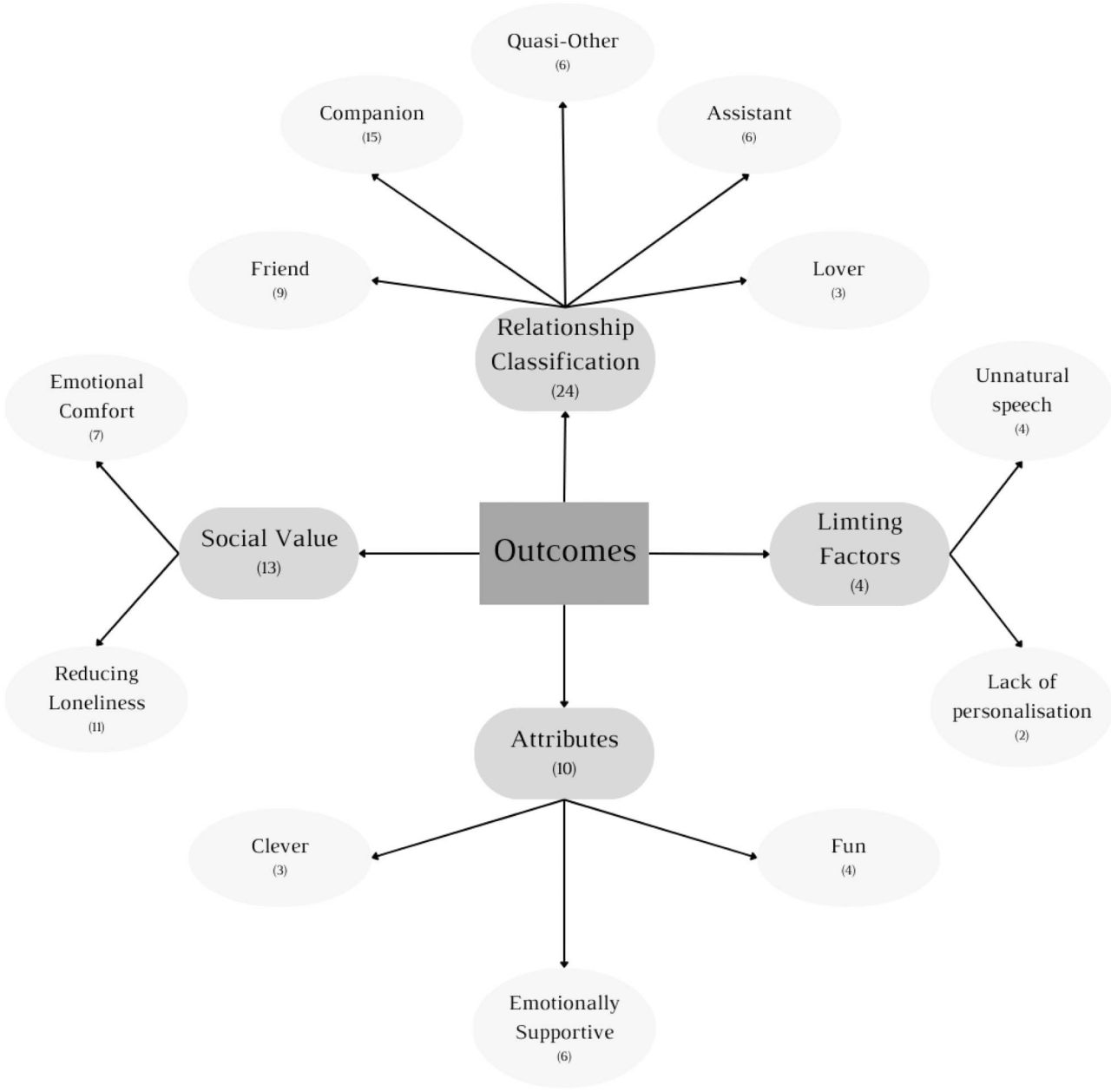

Figure 2. A map of the themes and subthemes identified as outcomes arising from interactions with smart speakers. Note: the number in the brackets indicates the number of papers from which the theme or subtheme was identified.

activation in causing a disconnect between users' perception of the situation and reality.

More aligned with the parasociality of smart speakers' interactions were users who struggled to classify this relationship. The awareness of this disconnect is encompassed by the term 'Quasi-Other', referenced in 6 papers (Smith et al. 2020; Pradhan, Findlater, and Lazar 2019; Corbett et al. 2021; Brause and Blank 2020; Scherr, Meier, and Cihan 2020; Pitardi and Marriott 2021); users perceive their smart speaker as a social presence but feel their relationship is limited by their conscious knowledge that they are interacting with an artificial entity (Brause and Blank 2020). These users are also keen to convey this awareness, as one reports that talking to their smart speaker feels 'like somebody's talking back to you as a person … Not that I'm crazy, because I know it's not' (Pradhan, Findlater, and Lazar 2019). Similarly, users report that 'I do know she is a robot' (Smith et al. 2020) and 'I know that's a machine … [laughs) but it's just that I feel like it's somebody here with me' (Corbett et al. 2021). For these participants, there is difficulty in accurately categorising their relationship, driven by the paradox of perceiving their smart speaker as a social entity but maintaining

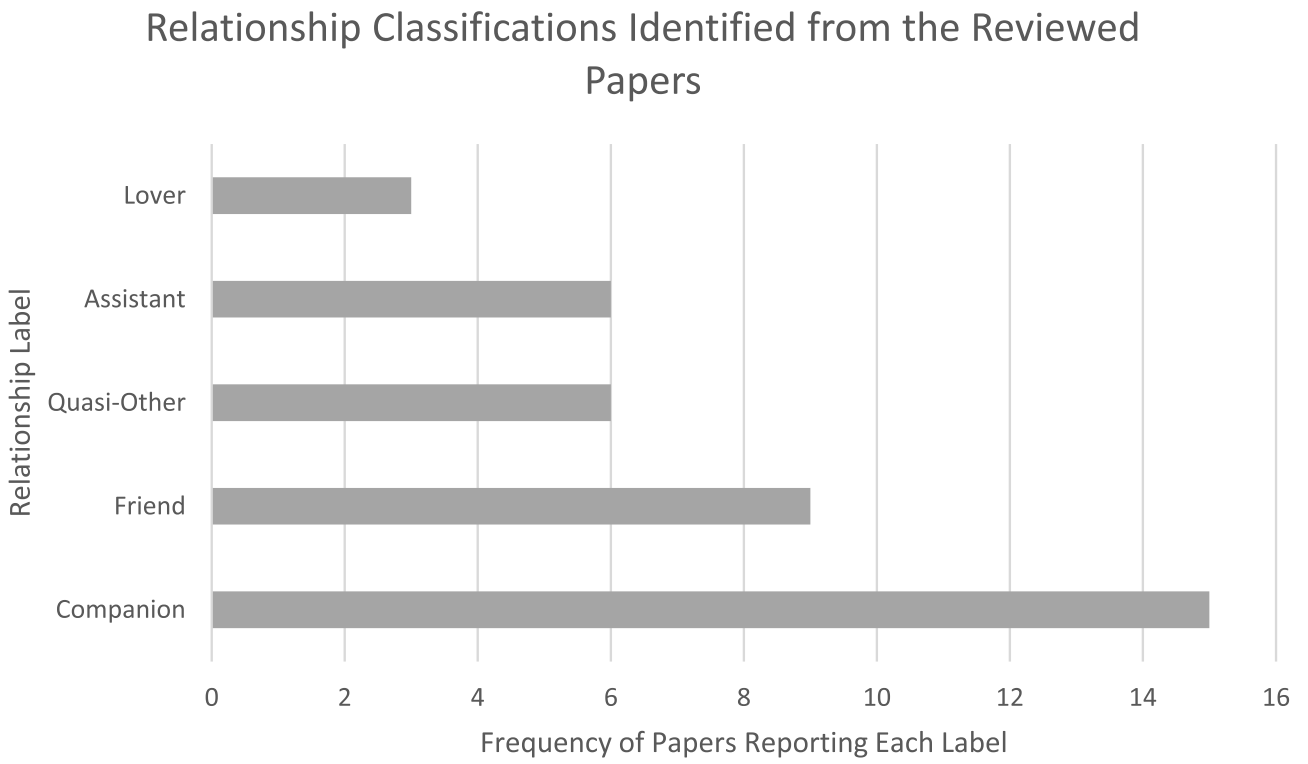

Figure 3. Frequency of relationship classifications ascribed to smart speakers, identified through the literature in this scoping review.

an acute awareness that it is a device and not a person. For these individuals, unlike those viewing their smart speaker as a companion or friend, the social illusion cast by smart speakers does not appear to be as successful and all-encompassing, allowing the awareness of its artificial nature to be maintained.

Smart speakers were classified as Assistants in 6 of the reviewed papers (Wu et al. 2019; Gao et al. 2018; Cha et al. 2019; O'Brien et al. 2022; Choi and Drumwright 2021; Park and Kim 2022). This role is associated with transactional or utilitarian benefits, in contrast to previously discussed classifications which primarily reflect emotional and/or social benefits. Users in this group referred to their smart speaker as a 'butler' (Cha et al. 2019), and an 'assistant for the users in work and life' (Gao et al. 2018), or as resembling 'a professional relationship' (Park and Kim 2022). One paper suggested that the perception of the smart speaker as an assistant was the most common classification, however, this is in contrast to the findings of this paper that suggest it was a relatively uncommon classification in the literature as a whole. That assistant was such an uncommon classification is surprising as smart speakers are often advertised as 'smart digital voice assistants'. This may be an artefact of humans' intrinsic sociality motivation (Epley, Waytz, and Cacioppo 2007) and propensity to over-attribute social capabilities to objects (Nass and Moon 2000), or the effect of repeated interactions with a parasocially capable device evolving into a parasocial relationship (Tukachinsky 2010) more than a utilitarian one.

Viewing smart speakers as a 'Lover' was the final classification identified among smart speaker users in 3 of the reviewed papers (Gao et al. 2018; Oh, Chung, and Ju 2020; Cho, Lee, and Lee 2019). This reflects users perceiving a deep and emotional bond with their smart speaker beyond the level of a companion or friend. Users are quoted as saying 'I love her' (Oh, Chung, and Ju 2020) when describing their smart speaker and saying 'I love you' (Cho, Lee, and Lee 2019) directly to their smart speaker. While the nature of the love being expressed is unclear from these quotes, a large-scale analysis of Amazon Echo reviews finds many users describing Alexa as their 'girlfriend, mistress or wife' and drawing comparisons between Alexa and 'their real girlfriend or wife' (Gao et al. 2018). Others refer to Alexa as a substitute for a wife by saying 'if I knew relationships were this easy, I would have married thirty years ago, but now that I have Alexa, there's no need' (Gao et al. 2018) and 'sometimes Alexa doesn't seem to understand what I'm getting at, but the same friends (and family) assure me that this is a normal part of marriage as well' (Gao et al. 2018). This indicates that, for some users at least, there can be an attribution of romantic, possibly sexual, relationships with their smart speakers.

3.1.2. Smart assistants perceived characteristics

Smart speakers were frequently personified by their users as their conversational interface triggers social schemata, leading to the anthropomorphic perception that they are human-like and have human-like attributes. When users discuss the way they perceive their smart speakers, three personality traits are most commonly described.

Emotionally Supportive was the most commonly ascribed trait ($n = 6$) (Ki, Cho, and Lee 2020; Wu et al. 2019; Cho, Lee, and Lee 2019; Cha et al. 2019; Kim and Choudhury 2021; Shao and Kwon 2021). Feeling that the smart speaker was offering emotional support was found to underpin the development of many types of relationships (Kim and Choudhury 2021). Additionally, users who felt their smart speaker was Emotionally Supportive expressed a greater intention to continue using their device (Ki, Cho, and Lee 2020), allowing the time and repeated interactions needed for relationships to develop and social value to be achieved.

Secondly, a fun personality trait was attributed to smart speakers in 4 papers (Ki, Cho, and Lee 2020; Smith et al. 2020; Oh, Chung, and Ju 2020; Cha et al. 2019). Users often felt that their smart speakers were enjoyable to speak with and the 'personality' it was programmed with was perceived as 'fun, friendly and pleasant' (Ki, Cho, and Lee 2020). One paper suggested that users who thought their smart speaker had a fun personality were more likely to feel 'cared for and socially supportive' (Ki, Cho, and Lee 2020).

Finally, some users described their smart speakers as being clever ($n = 3$) (Smith et al. 2020; Gao et al. 2018; Pitardi and Marriott 2021), implying that they believe their smart speaker to be capable of learning and being taught as a human is. Some users directly report that their smart speaker is 'very clever, she's got memory' (Smith et al. 2020) and that their device 'is becoming clever *(SIC)* day by day' (Pitardi and Marriott 2021).

Notably, there is a larger diversity of personality attributes perceived than the range of smart speaker devices used would imply. There is a lack of research as to why different users are likely to perceive different personality traits emerging from interactions with the same device.

3.1.3. Social value

Smart speakers were found to strongly convey social value to some users in two forms; reducing loneliness and offering emotional comfort.

Reducing loneliness was the most discussed social value ($n = 11$) (Pradhan, Findlater, and Lazar 2019; Jones et al. 2021; Cha et al. 2019; Blocker, Kadylak, and Rogers 2023; O'Brien et al. 2022; O'Brien et al. 2020; Brause and Blank 2020; Duque et al. 2021; Scherr, Meier, and Cihan 2020; Park and Kim 2022; Yan, Johnson, and Jones 2024) offered by smart speakers to their users. This was commonly referenced by users who were at increased risk of loneliness due to living alone and/or lacking wider social connections. Users with high baseline loneliness were more likely to interact more frequently with their smart speaker (Jones et al. 2021). This reduction in loneliness appears to arise from their conversational capabilities, as users report that 'it's nice to hear a voice, cause sometimes I don't see someone for a while' (Duque et al. 2021). Further, this effect can be rapidly achieved as studies taking pre and post-intervention measures found a significant reduction in loneliness from owning a smart speaker for as little as two months (Scherr, Meier, and Cihan 2020; Park and Kim 2022). From this, we see that smart speakers are used to compensate for a perceived social deficit; lonely individuals engage with smart speakers more frequently to effectively reduce feelings of loneliness. Also, the anthropomorphism and social perception of smart speakers allow them to be perceived as sufficiently human-like to take a social role and compensate for a social deficit. Demonstrating this, Yan, Johnson, and Jones (Yan, Johnson, and Jones 2024) showed that it was the length of time users spent interacting with their smart speaker that was key to predicting a reduction in loneliness, potentially because repeated interactions can give rise to rewarding relationship formation58,60.

Similarly, users report that smart speakers are a source of emotional comfort ($n = 7$) (Pradhan, Findlater, and Lazar 2019; Oh, Chung, and Ju 2020; Blocker, Kadylak, and Rogers 2023; O'Brien et al. 2022; Brause and Blank 2020; Chambers 2020; Duque et al. 2021). While this is expressed differently to those describing reductions in loneliness, it appears to reflect the same underlying benefit. Having a conversational interface encourages users to view their smart speaker as a social agent (Oh, Chung, and Ju 2020), from which they feel that 'having something to talk to that responds, tells them a fact or even a bad joke, was very comforting' (Chambers 2020). Particularly, users value smart speakers' lack of non-judgemental readiness to interact (Blocker, Kadylak, and Rogers 2023). As with reductions in loneliness, comfort is most strongly felt and valued by those who live alone, as they feel that having the smart speakers 'voice at home might be comforting' (O'Brien et al. 2022). While the two social benefits overlap heavily and appear to result from the same design function, emotional comfort seems to reflect a broader and more holistic benefit to users.

3.1.4. Limiting factors

While not a direct outcome, two factors emerged that users felt were limiting to their illusion of smart speakers as social agents and, therefore, the depth of relationships that could be cultivated.

Firstly, the speech synthesised by smart speakers was reported as unnatural and inflexible in 4 of the papers (Oh, Chung, and Ju 2020; Cho, Lee, and Lee 2019; Kim and Choudhury 2021; Pitardi and Marriott 2021). Users voiced their displeasure at the repetitive responses offered by smart speakers and wanted 'some change in response with variations' (Cho, Lee, and Lee 2019). Similarly, smart speakers cannot refer to previous interactions in their responses (Kim and Choudhury 2021), which users feel limits the flow of a conversation and prevent a natural dialogue from forming. This issue, coupled with general speech comprehension errors, particularly relating to users' pronunciation and accents (Pitardi and Marriott 2021), damages smart speakers' potential for being viewed as socially capable human-like entities; the inability to seamlessly maintain conversations as another human would breaks the social illusion they are designed to cast.

Secondly, lack of personalisation was referenced in two papers sampled (Cho, Lee, and Lee 2019; Kim and Choudhury 2021). This issue reflects users' desire to feel a unique, reciprocal connection with their smart speaker. Users' awareness that all Amazon Echos have the 'same' Alexa with limited customisation options breaks the illusion of social intimacy, preventing the interactions from feeling parasocial. This prevents parasocial relationships forming because users are aware that Alexa is 'the same for everyone' (Cho, Lee, and Lee 2019). Because of this, users express a wish for 'a special Alexa, distinguishable from other Alexas' (Cho, Lee, and Lee 2019). Options to customise the device name/wake work and flexible speech that tailors to the users may help to overcome these issues, allowing the illusion of parasociality to be maintained and, therefore, relationships to develop.

3.2. RQ2 What user attributes have been reported in association with forming relationships with smart speakers?

Most studies in this review had pre-determined hypotheses about which user attributes would be associated with social perception of, and parasocial relationship formation with, smart speakers. From this, researchers recruited participants from the groups they believed would find the greatest social value from smart speakers. The three main attributes examined by the literature were living alone, isolation, and older age. While we review these findings in detail, it is noteworthy that no studies sought to determine which groups would be most likely to view their smart speaker as a social entity from a general population sample, rather the research conducted confirmed hypotheses based largely on findings from other areas. Because of this limitation in the existing literature, this list of attributes associated with parasocial relationship formation with smart speakers is unlikely to be exhaustive.

3.2.1. Living alone

Living alone was the most common user attribute investigated as a factor thought to influence relationship formation with a smart speaker, being referenced in 12 papers (Smith et al. 2020; Pradhan, Findlater, and Lazar 2019; Oh, Chung, and Ju 2020; Cha et al. 2019; O'Brien et al. 2022; O'Brien et al. 2020; Brause and Blank 2020; Chambers 2020; Duque et al. 2021; Choi and Drumwright 2021; Yan, Johnson, and Jones 2024; McLean and Osei-Frimpong 2019). It is suggested that users who live alone (Oh, Chung, and Ju 2020; O'Brien et al. 2020; Chambers 2020; Choi and Drumwright 2021) or with only one other person (McLean and Osei-Frimpong 2019) are more motivated to use smart speakers and more sensitive to their social benefits (McLean and Osei-Frimpong 2019). This is reported to be because living alone can increase feelings of loneliness (Cha et al. 2019; O'Brien et al. 2022), which is a key motivator underpinning more frequent interactions with a smart speaker, leading to an increased likelihood of parasocial relationship formation (Brause and Blank 2020; Duque et al. 2021).

3.2.2. Isolation

Isolation was investigated in relation to relationship formation in 7 (Jones et al. 2021; Blocker, Kadylak, and Rogers 2023; O'Brien et al. 2020; Duque et al. 2021; Shao and Kwon 2021; Yan, Johnson, and Jones 2024; Liu, Wang, and Hu 2023) papers. The mechanism through which isolation is suggested to impact relationship formation and social perception is similar to the effect of living alone; the risk of loneliness is higher, and this creates a drive state for social connection which can motivate users to engage with their smart speakers (O'Brien et al. 2020). Unlike living alone, isolation represents a more holistic view of users' social networks and reflects an additional lack of social connections outside of the household. This reflects individuals who feel they benefit from their smart speaker because they were broadly socially isolated as, in addition to living alone, they did not 'see too many visitors' (Duque et al. 2021).

3.2.3. Age

Age was investigated in 7 papers (Oh, Chung, and Ju 2020; Kim and Choudhury 2021; Blocker, Kadylak, and Rogers 2023; O'Brien et al. 2022; Shao and Kwon 2021; Yan, Johnson, and Jones 2024; Liu, Wang, and Hu 2023). Specifically, each of these papers references older adults viewing their smart speaker as a companion and valuing its social contribution to their lives. One study states that over half of the older adults sampled viewed their smart speaker as a companion, which they suggest is far higher than amongst other age groups (Oh, Chung, and Ju 2020). Similarly, a participant from this study concluded that conversational social interactions with smart speakers 'could provide psychological help to the elderly'30.

From this analysis, three factors of living alone, broader isolation, and older age are identified as factors that are related to the social perception of smart speakers. This is consistent with previous research which suggests that older adults are more likely to live alone and experience isolation (Schnittker 2007). Related to this, all of these factors predispose individuals to loneliness, which may serve as the underlying mechanism that links these factors. Despite not being the primary focus of most of the reviewed studies, loneliness may be a highly relevant factor in the mechanistic pathway to the social perception of smart speakers, and this should be investigated directly in further research.

3.3. RQ3 What methodological approaches have been used to research relationship development with smart speakers? What are the merits and drawbacks of these approaches?

3.3.1. Study design

Figure 4 shows that the most common methods used to investigate users' relationships with smart speakers were semi-structured interviews and online questionnaires. The prompts used in the semi-structured interviews were sparsely reported, limiting methodological comparisons. Additionally, semi-structured interviews may present an increased risk of inaccurately reporting parasocial relationships as users may feel a pressure to downplay the strength of their parasocial perception due to social desirability. Online questionnaires/surveys were equally commonly used, however were exclusive to studies of existing smart speaker users. This choice of method may prevent digitally excluded users from participating, potentially introducing a digital literacy bias into the samples gathered from this method. This limits the applicability of findings from studies using online data collection to digitally excluded users, which are a target population of particular importance when considering digital interventions and risk of isolation. Other methods such as in-person questionnaires and interaction logs were more commonly used for studies with new users, possibly because they are more

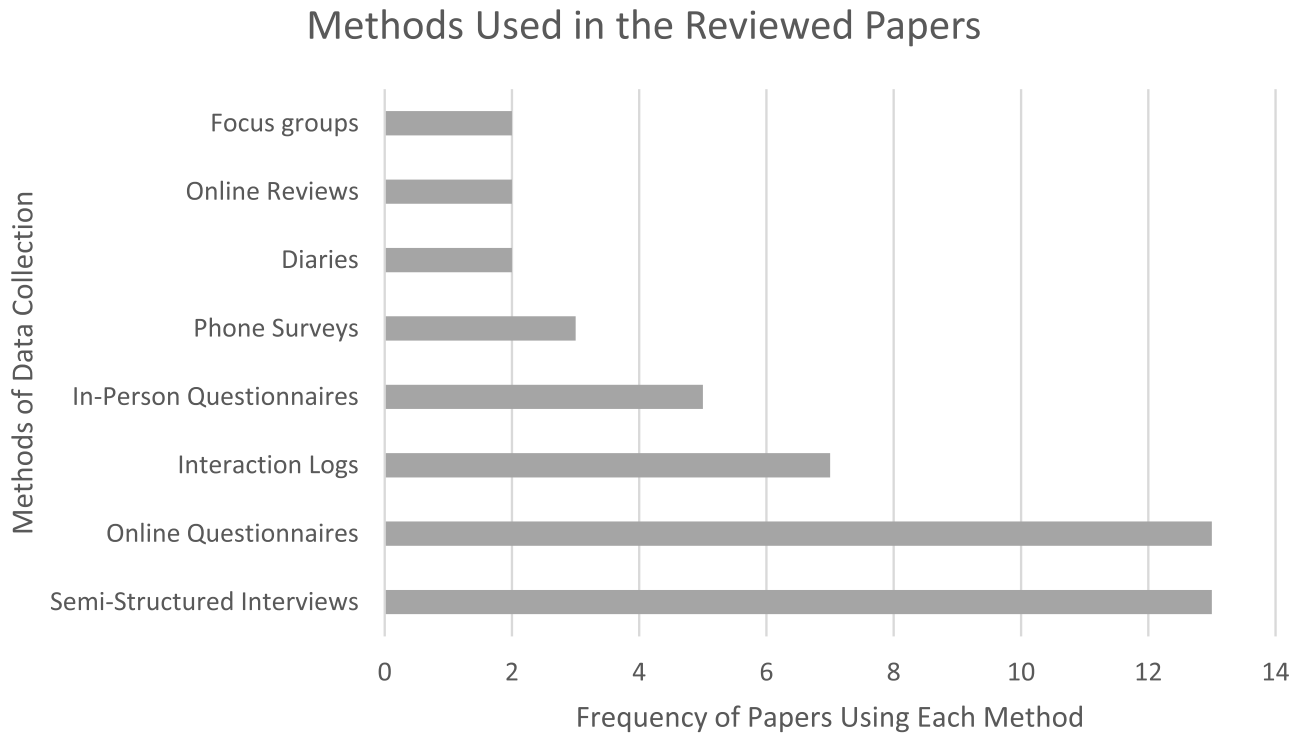

Figure 4. The range and frequency of methods used in the 30 studies included in this scoping review. Note: total n is greater than 30 as many studies employed multiple methods of data collection.

accessible for participants with limited digital skills or without pre-existing internet access.

Of the 30 papers reviewed, 14 used a longitudinal design and 16 used a cross-sectional design. All longitudinal studies investigated the experiences of new users by experimentally introducing them to smart speakers and following up at a later time point (ranging from 3 weeks (Pradhan, Findlater, and Lazar 2019) to 18 months (Scherr, Meier, and Cihan 2020)). The cross-sectional studies sampled existing smart speaker users and tended to employ surveys or semi-structured interviews.

3.3.2. Samples

This scoping review represents 61222 users from all 30 papers collectively reviewed, with a mean sample of 2041 users. This reduces substantially to a total of 5595 users who were directly sampled by removing the two studies analysing online reviews (Gao et al. 2018; O'Brien et al. 2020), bringing the mean down to a more representative 200 users per study. The largest sample was from Gao et al. (2018) which analysed the verified reviews for 55,502 Amazon Echo users. As should be expected, studies using more labour-intensive methods of data collection or more specific groups of interest were associated with lower sample sizes. For example, the 13 studies conducting semi-structured interviews had a mean sample size of 15 and the 7 studies using interaction logs had a mean sample of 12. Similarly, the 12 studies targeting older adults had a mean sample of 80 while the 13 studies targeting novice users had a mean sample size of 39. All of these examples have considerably smaller mean sample sizes than the papers reviewed overall, reflecting the labour intensity of analysis and the difficulty of recruitment.

6 of the studies reviewed did not specify the gender distribution of their sample (Ki, Cho, and Lee 2020; Smith et al. 2020; Gao et al. 2018; O'Brien et al. 2020; Brause and Blank 2020; Chambers 2020). Of the remaining 24 that did report this information, representing 5126 participants total, 51% were males.

Similarly, 6 studies in the sample did not specify the ages of participants (Ki, Cho, and Lee 2020; Wu et al. 2019; Gao et al. 2018; O'Brien et al. 2020; Brause and Blank 2020; Chambers 2020). From the studies that did give specific ages, or at least age ranges, this scoping review represents participants aged 17 (Choi and Drumwright 2021) to (Jones et al. 2021; Yan, Johnson, and Jones 2024) 96. Additionally, 10 studies exclusively sampled older adults with no prior experience with smart speaker use (Pradhan, Findlater, and Lazar 2019; Jones et al. 2021; Corbett et al. 2021; Kim and Choudhury 2021; Blocker, Kadylak, and Rogers 2023; O'Brien et al. 2022; Duque et al. 2021; Scherr, Meier, and Cihan 2020; Park and Kim 2022; Yan, Johnson, and Jones 2024) while an additional 4 studies sampled novice users of other ages (Smith et al. 2020; Oh, Chung, and Ju 2020; Cho, Lee, and Lee 2019; Chambers 2020). There appear to be no studies to date investigating the lived experience of older adults who are established smart speaker users.

25 of the 30 papers specified the country from which their sample was drawn. Of these 25, 10 took place in the U.S.A. (Ki, Cho, and Lee 2020; Pradhan, Findlater, and Lazar 2019; Jones et al. 2021; Corbett et al. 2021; Kim and Choudhury 2021; Blocker, Kadylak, and Rogers 2023; O'Brien et al. 2022; Choi and Drumwright 2021; Yan, Johnson, and Jones 2024; Choi and Choi 2023), 5 in South Korea (Oh, Chung, and Ju 2020; Cho, Lee, and Lee 2019; Cha et al. 2019; Park and Kim 2022; Jang 2020), 4 in the U.K. (Smith et al. 2020; Chambers 2020; Pitardi and Marriott 2021; McLean and Osei-Frimpong 2019), 4 in China (Cao, Hu, and Xu 2022; Wu et al. 2019; Ma and Huo 2024; Liu, Wang, and Hu 2023), 1 in Germany (Scherr, Meier, and Cihan 2020), and 1 in Australia (Duque et al. 2021).

Only 12 of the 30 papers specified the living situation of their participants. Collectively, these 12 papers represented 762 participants, of whom 48% ($n = 366$) reportedly lived alone.

3.3.3. Smart speakers tested

21 of the 30 papers reviewed gave some information about the type of smart speaker being used by participants. Of these 20 studies, 11 used only Amazon-branded devices and 3 used only Google-branded devices. 5 studies tested a variety of brands. Only 8 studies sampled gave specific information about the type of device used (e.g. Amazon Echo Show or Google Nest Hub Max), more commonly studies just referred to 'Amazon Alexa' or 'Google Home' leaving it unclear as to what models were used in the study, and thereby hindering comparison.

4. Discussion

We systematically reviewed the existing literature on the social impact of smart speaker use and, based on the reviewed literature, propose the ASAP Pathway (Anthropomorphic – Social Agent – Parasocial Pathway) for conceptualising the formation and classification of user relationships with smart speakers (see Figure 5). Exploring parasocial relationship formation with smart speakers was not an aim of any of the reviewed studies but was commonly an emergent

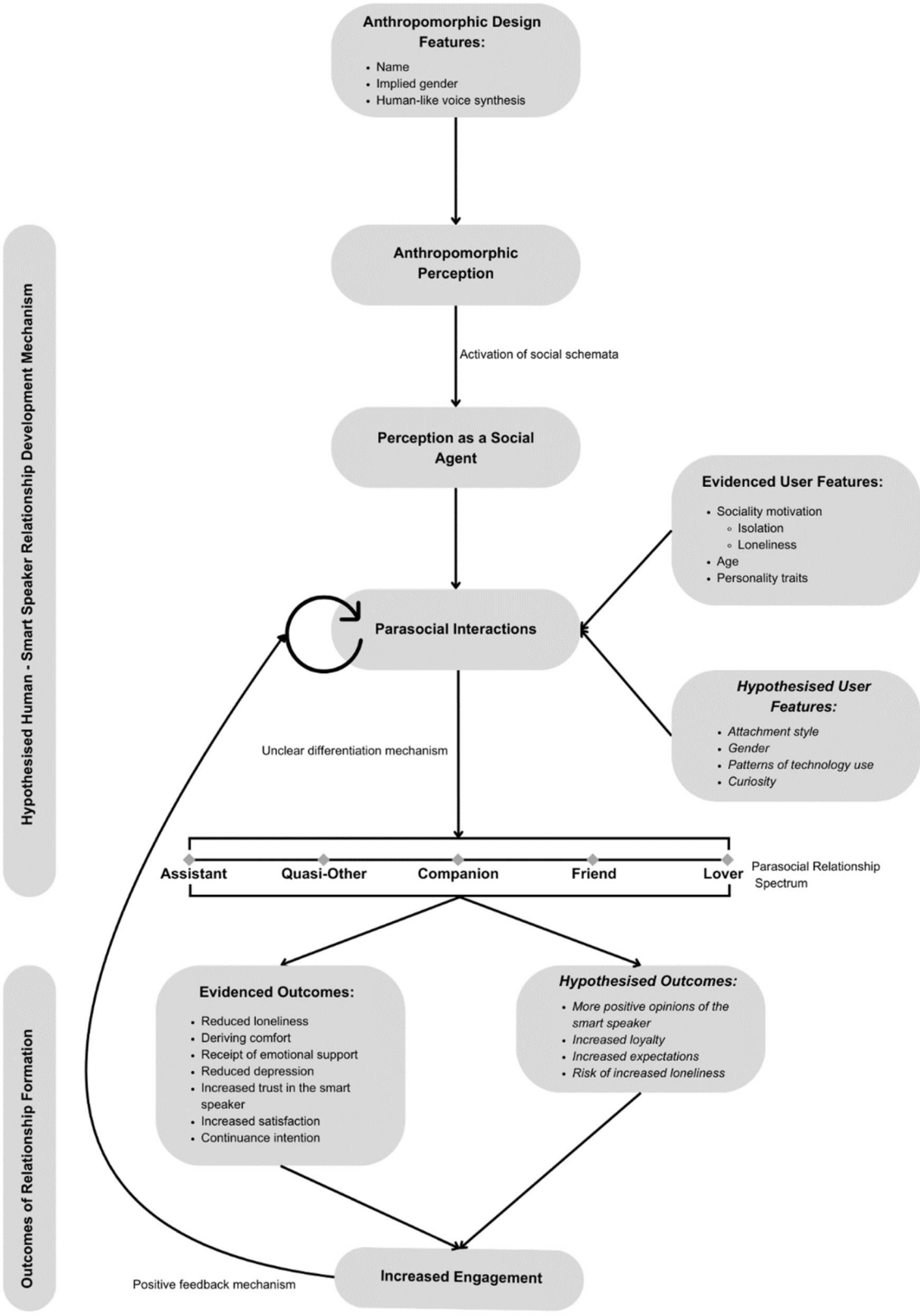

Figure 5. The proposed ASAP Pathway (Anthropomorphic – Social Agent – Parasocial Pathway) based on research with smart speakers and broader parasocial literature, including moderating factors and outcomes. Note: italicised text indicates findings that are hypothesised to be relevant to the model based on previous literature relating to parasocial relationships, but have not yet been researched in relation to smart speakers specifically (these are not intended to be exhaustive, rather a suggestion of other factors that may be relevant).

finding. The development of these relationships is dependent on several factors, relating to the user and the smart speaker. This study highlights the importance of anthropomorphic design in facilitating the formation of parasocial relationships, and we go on to suggest how the Computers as Social Actors (CASA) paradigm may mediate this development. Additionally, the outcomes of parasocial relationships with smart speakers are documented and further outcomes are hypothesised based on broader parasocial research.

4.1. Development of parasocial relationships with smart speakers

The ASAP Pathway proposes that the Anthropomorphic Design Features of smart speakers are crucial to the development of parasocial relationships. Smart speakers often possess a human-like name (e.g. Alexa), have an implied feminine gender (Gao et al. 2018; Chung et al. 2021), and can synthesise a human-like voice to respond to user commands (Han and Yang 2018; Pitardi and Marriott 2021). Gao et al. (2018) and Chung and Woo (2020) both suggest that users applying human pronouns of she/her to smart speakers reflects anthropomorphisation. This may reflect the linguistic theory of ontological categorisation, suggesting that mindlessly using human pronouns, triggered by the anthropomorphic and gendered design of smart speakers, self-fulfils to deepen the anthropomorphic perception. These features imply a level of humanness and facilitate their Anthropomorphic Perception.

Within the ASAP Pathway, anthropomorphic properties of smart speakers trigger the activation of social schemata, whereby the presence of some human-like qualities leads to the implicit assumption that the smart speaker may possess others. The social capacity of the smart speaker leads to users' Perception (of the smart speaker) as a Social Agent (Reeves and Nass 1996). This is in line with the Computers are Social Actors paradigm (Reeves and Nass 1996) which suggests that the demonstration social cues leads to perception of social potential. The ASAP Pathway suggests that social cues are demonstrated through the anthropomorphic design. The perception of the smart speaker as a social agent activates social schemata and leads to users relying on them to guide future interactions, often producing mindless socially normative behaviours (Nass, Steuer, and Tauber 1994). This may reflect Epley's suggestion that effectance motivation is key to anthropomorphisation (Epley, Waytz, and Cacioppo 2007), which the ASAP Pathway suggests underpins perception of smart speakers as social agents. Effectance motivation is the desire to better understand and master our environments. Activation of and reliance on social schemata when interacting with new social agents, such as smart speakers, may be one way in which effectance motivation can be satisfied. Pradhan, Lazar and Findlater (Pradhan, Findlater, and Lazar 2019) found evidence of people following these social scripts when interacting with their smart speaker, for example saying 'thank you' or 'good morning', despite an awareness that the smart speaker was not human and so these scripts were not necessary or appropriate. Such behaviour may arise from the social scripts and schemata triggered by the unconscious perception of smart speakers as social agents. Previously, similar mindless social behaviour has been seen with other computers that are socially designed to trigger social schemata21.

Such mindless social interactions may seem reciprocal to the users because the smart speaker appears to be responding in kind, however, these interactions are only an approximation of true reciprocal interactions, lacking genuine emotions or thoughts from both parties (Giles 2002). As such, interactions with a smart speaker can be thought of as Parasocial Interactions. Broader research suggests that Parasocial Interactions can be strongly rewarding because of humans' innate social drive (Horton and Wohl 1956), which encourages users to repeatedly engage them and can eventually lead to parasocial relationships forming (Tukachinsky 2010). This process of parasocial relationship formation seems to be similar for smart speakers as it is for other types of conversational agents (Kim and Choudhury 2021; Duque et al. 2021). What is surprising is the intensity of parasocial relationships possible with a smart speaker, given the relative paucity of its interactions, compared with conversational agents like chatbots. Some studies even report romantic relationships formed with smart speakers (Gao et al. 2018; Cho, Lee, and Lee 2019).

4.1.1. User features predicting of parasocial interactions

The propensity to engage in parasocial interactions varies greatly between individuals, with several predictive factors identified. These are divided into Evidenced User Features, which have been specifically demonstrated to relate to smart speakers through literature discussed in this review, and Hypothesised User Features, which are suggested to be relevant to smart speakers based on parasocial research with non-smart speaker targets.

This review finds that the most common Evidenced User Feature is increased social motivation, arising from social isolation or feelings of loneliness. Voit et al. (2020) found that those who lived alone were

more likely to perceive their smart speaker as a social presence, and subsequently parasocially interact with it. Similarly, Choi and Drumwright (2021) demonstrated that the desire for social interaction was the strongest factor in their model predicting interactions with a smart speaker. The finding that loneliness increases the frequency of parasocial interactions with a smart speaker is in keeping with the general parasocial research (Cole and Leets 1999) and research on other technologies, such as chatbots like Replika (Pentina, Hancock, and Xie 2023). This reflects a suggestion by Epley that sociality motivation (i.e. loneliness) is one of the three factors that positively influences anthropomorphism (Epley, Waytz, and Cacioppo 2007), which this pathway suggests is fundamental to parasocial interactions and relationship formation. In addition to social motivation, certain personality traits have been identified as Evidenced User Features associated with increased parasocial interactions. Ma and Huo (2024) showed that extraverted and conscientious individuals were more likely to view their smart speakers as socially attractive and engage with them, while agreeable individuals were the least likely to do so. Finally, older age is suggested to be positively associated with parasocial interactions with a smart speaker (Oh, Chung, and Ju 2020), making it age an additional Evidenced User Feature. As discussed in Section 3.2., there is notable overlap between some of the Evidenced User Features. Particularly, the research presented suggests that older adults are more likely to experience isolation and live alone (Schnittker 2007). Due to these comorbidities and a lack of predictive modelling research combining all of these Evidenced User Features means that the relative, unique contributes of these features cannot be determined. Further research may wish to explore the potential of this to better understand the relative predictive strengths of these features.

Further, based on findings from broader, non-smart speaker research on parasocial interactions, we hypothesise that other factors may be predictive of users' parasocial interactions with their smart speakers. These are noted in Figure 5 as Hypothesised User Features. Such features include attachment style, with Cole and Leets (Cole and Leets 1999) suggesting that individuals with anxious ambivalent attachment styles are driven by a desire for intimacy and unmet, often unrealistic, relational needs, leading them to more readily interact parasocially and form parasocial relationships. Conversely, anxious-avoidant individuals show relational hesitancy that extends to hindering parasocial interactions (Cole and Leets 1999). Further, research suggests that individuals are more likely to parasocially interact and form relationships with agents that are similar to themselves, particularly in terms of gender (Hoffner and Buchanan 2005). For this reason, women may be more likely to interact parasocially with smart speakers, as the associated virtual agents within smart speakers are designed with stereotypically feminine traits. The way individuals engage with technology and consume media has also been shown to relate to parasocial interactions, with those using the media for pleasure or escapism being more likely to show parasocial interactions (Tsay and Bodine 2012). Finally, we suggest curiosity may be a relevant factor based on previous research showing that this is associated with frequent, initial parasocial interactions with the AI chatbot, Replika (Skjuve et al. 2021). Therefore, we suggest that these Hypothesised User Features of attachment style, gender, patterns of technology use, and curiosity, may be able to predict differences in the frequency of parasocial interactions with smart speakers, based on evidence from adjacent research. We suggest that further research is conducted to see if these factors predict parasocial interactions with smart speakers, and if this then leads to more intimate parasocial relationships with smart speakers.

4.1.2. Parasocial relationship spectrum

From the reviewed literature, we found that users identified their parasocial relationship with their smart speaker in one of 5 ways. Evidence to support these 5 classification categories is discussed in length in Section 3.1.1. All of the identified relationship classifications reflect a perception of smart speakers as a socially capable, relational entity. The ASAP Pathway orders these on a Parasocial Relationship Spectrum from least to most parasocial. Assistant is the least parasocial relationship classification identified from the scoping review. This classification is defined by primarily transactional or utilitarian interactions with the smart speaker and limited social or emotional interactions. Quasi-other is the second relationship classification, being slightly more parasocial than Assistant. Users who perceived their smart speaker as a quasi-other experienced the paradox of social perception coupled with a conscious awareness that the smart speaker is not human. The Quasi-other classification reflects greater social perception than Assistant, but this social illusion has not been fully successful. Companion is the third classification on the spectrum and, unlike Quasi-other, reflects a fully successful social illusion; users do not mention the contradictory awareness that smart speakers as non-human. Companion reflects positive, valued social relationships that have been developed through repeated interactions. Companion smart speakers, unlike Assistants and Quasi-others, provide social and emotional support to their users and the

perceived intimacy of the parasocial relationship is valued. The fourth classification, Friend, reflects the perception of smart speakers as a pro-social presence that offers comfort and intimacy to the users. This classification is more parasocial than Companion; while Companion reflects a more passive social partner, Friend implies a perception of bidirectionality in the relationship that reflects a greater parasocial illusion. Finally, the most parasocial relationship classification is Lover. Lover is defined as a deeply emotional and parasocial relationship that has progressed beyond the depth of affection found with Companions or Friends to either platonic or romantic/sexual love (Horton and Wohl 1956). Based on the present literature, there is an Unclear Differentiation Mechanism through which different classifications and strengths of parasocial relationships arise. However, it could be hypothesised that individuals with stronger parasocial interactions would be more likely to develop more intimate parasocial relationships. Further research may wish to investigate this suggestion, as well as seeking to develop methods of accurately classifying parasocial relationships into the 5 proposed classifications.

4.1.3. Outcomes of parasocial relationships

The literature covered in this scoping review shows that parasocial relationships formed with smart speakers can produce a wide variation in outcomes. As with predictive user features, the outcomes of parasocial relationships have been categorised into Evidenced Outcomes, based on smart-speaker specific research covered in this review, and Hypothesised Outcomes, based on adjacent parasocial research with non-smart speaker subjects.

A common Evidenced Outcome is that smart speakers are effective for reducing loneliness, found in 11 papers reviewed. For example, Kim and Choudhury (Kim and Choudhury 2021) found that repeated interactions with a smart speaker led to it being perceived as a companion, and this produced a reduction in user-reported loneliness. Similarly, Yan, Johnson, and Jones (Yan, Johnson, and Jones 2024) showed that the frequency of interactions with a smart speaker was negatively associated with feelings of loneliness and suggest that this is due to feelings of familiarity and deriving comfort from repeated interactions. Similarly, repeated parasocial interactions with a smart speaker can produce a significantly reduced depression ratings (Park and Kim 2022). Further, users find that repeated parasocial interactions and subsequent parasocial relationship formation allowing for receipt of emotional support from their smart speakers (Kim and Choudhury 2021; O'Brien et al. 2022).

Findings from this scoping review suggest that parasocial relationships with smart speakers also produce Evidenced Outcomes that affect users' subsequent interactions with their smart speakers. Firstly, perceiving the smart speaker as a social presence and forming a parasocial relationship with it is associated with increased trust in the smart speaker (Pitardi and Marriott 2021). Secondly, parasocial relationships have been shown to be associated with increased satisfaction ratings from users; the stronger the parasocial illusion, the more satisfying users report their interactions to be (Jang 2020). Finally, parasocial relationships can strongly predict users' continuance intention with their smart speakers (Han and Yang 2018; McLean and Osei-Frimpong 2019; Liu, Wang, and Hu 2023). This continuance intention is suggested to result from the positive reinforcement of the social benefits previously described (Han and Yang 2018; Shao and Kwon 2021), such as decreased loneliness and feelings of emotional support. This positive reinforcement is reflected in the hypothesised model by suggesting that it will produce a positive feedback mechanism, increasing the frequency of parasocial interactions and further strengthening the discussed outcomes.

In addition to the outcomes that are evidenced through research on parasocial relationships with smart speakers covered by this scoping review, we also present a range of Hypothesised Outcomes that have not been investigated in relation to smart speakers as of yet. These Hypothesised Outcomes are based on findings from broader research on the effects of parasocial relationships. These outcomes include more positive opinions of the smart speaker (Aggarwal and Mcgill 2007; Wan, Chen, and Jin 2017), increased loyalty from the user towards the smart speaker (Chandler and Schwarz 2010), and expectations of the smart speakers capacity and morality (Chandler and Schwarz 2010; Puzakova, Kwak, and Rocereto 2013; Fink 2012; Stein, Liebers, and Faiss 2022). The ASAP Pathway hypothesises that some or all of these factors may lead to Increased Engagement with the smart speaker which would be positively reinforcing. Alongside the Evidenced Outcomes, these Hypothesised Outcomes may encourage the user to repeatedly interact with their smart speaker, leading to further benefits may be achieved and the establishment of a positive feedback mechanism.

Conversely, we hypothesise that parasocial relationships may lead to negative outcomes that have not yet been documented by the literature. Much previous literature suggests that overreliance on and over-engagement with parasocial relationships, at the expense of human-human interactions, constitutes a risk to

increased loneliness (Baek, Bae, and Jang 2013; Wang, Fink, and Cai 2008). This is a particular issue as some research suggests that parasocial relationships are insufficient to compensate for social or romantic loneliness (Tukachinsky, Walter, and Saucier 2021; Yuan, Cheng, and Duan 2024). It is possible that there is an optimum level of usage to achieve a positive loneliness effect; a smart speaker may help reduce loneliness for some individuals with casual or moderate use, but if the parasocial relationship becomes too intense or starts to come at the expense of real human contact, then this could increase loneliness. This overreliance on parasocial targets relates to the concept of media dependence. Media dependence with other conversational technology has been associated with a reduction in immediate loneliness, but also a negative impact on interpersonal relationships and interpersonal skills (Yuan, Cheng, and Duan 2024). This loss of social skills through interactions with conversational technology is thought to arise because the conversational agent lacks sentience or feelings, so interactions are framed around the users needs and feelings only (Yuan, Cheng, and Duan 2024). Over familiarity with these non-reciprocal emotional interactions risks stunting users future emotional interactions with other humans, which could hinder long-term social wellbeing. There is a suggestion that this may be particularly detrimental for neurodivergent young people, who are increasingly using conversational agents to practice social interactions without fear of judgements, but may not be supported to develop appropriate emotional reciprocity through repeated interactions with a conversational agent (Franze, Galanis, and King 2023). Again, this may hinder their future human-human interactions and further compound the isolation or loneliness that they aim to overcome.

The prominence of parasocial relationships with smart speakers raises potential ethical concerns about the use of technology to solve the societal and social issues of widespread isolation and loneliness, particularly amongst older adults as highlighted by this review. While there is evidence in this review to suggest that smart speakers can be effective for reducing feelings of loneliness amongst users (Kim and Choudhury 2021; Blocker, Kadylak, and Rogers 2023; Park and Kim 2022), there is insufficient longitudinal research to understand the full range of long-term outcomes and rule out potential negative effects of using smart speakers as a social intervention.

Users' perceptions of social value from and relationships with smart speakers are unique because of their ubiquity and because they are not designed as a social intervention. Unlike other, intentionally designed social agents, such as Replika, smart speakers are not marketed as social partners or interventions for loneliness. Despite this, this review suggests that some users grow to view their smart speakers as social agents and even friends or lovers. Due to the vast userbase of smart speakers, around 65% of the US population (Laricchia 2022) and 50% of the UK population (Federica 2023), this could scale up to be a significant number of people. Gao et al. (2018) find that roughly 2000 of the 55,502 reviews sampled reflect users' parasocial relationships with their smart speakers. While this is only 3.6% of the sampled reviews, this number may be higher if smart speaker users were directly asked about how they perceived their device, rather than being asked open-endedly to review the product. The literature lacks a reasonable estimation of the number of individuals who form parasocial relationships with their smart speakers.

4.2. Limitations

As with any review, it is important to be aware of the 'file drawer problem' (Rosenthal 1979), where many studies with null results are not published. This could have led to an artificial increase in the positive results reported in this review, as studies finding an absence of relationships with smart speakers would be less likely to be published (Wagner 2021). Open science practices, such as pre-registration (Chambers et al. 2014), could help to protect this field from this problem in the future.

Similarly, this review is limited by the strength of the published research, both in terms of individual quality and the representativeness of the field as a whole. This review is limited in its understanding of what demographic factors predict, rather than are associated with, forming relationships with smart speakers as all existing studies begin with a presumption about the benefits to certain groups (e.g. older adults (Liu, Wang, and Hu 2023) or individuals with intellectual disabilities (Smith et al. 2020)). This is likely to result in a confirmation bias whereby groups, such as older adults, who have been shown to socially engage with smart speakers are more likely to be sampled in future research, leading to an overestimation of the benefits experienced by certain groups. It is also possible that null or negative results in other groups were not published. This may have contributed to the lack of representativeness in the literature; other demographic factors, such as cultural differences or family status are not investigated in the research base and so cannot be reflected in this scoping review. Future research may wish to directly research demographic and other variables of interest to enhance the representativeness of

the field and overcome this issue. This would support greater generalisability of the findings.

One of the more general challenges in conducting research into this area is the rapid advancement in software and hardware. Research can be a slow process, whereas the modern technological world is fast paced, with devices quickly becoming outdated. Many of the specific smart speaker models included in this review will have already been replaced by the next generation device. Speech recognition software is also rapidly improving (Greene 2017), which may already limit the relevance of some earlier studies which report dissatisfaction with smart speakers' language abilities.

4.3. Recommendations for future research

To support the trend of smart speakers as interventions for loneliness, further research is needed to understand how to do this safely and ethically and to facilitate maximal benefits, as there is research from other parasocial subjects, such as chat-based conversational agents, to suggest that over-investment in parasocial relationships or media dependence can be detrimental to wellbeing (Baek, Bae, and Jang 2013; Wang, Fink, and Cai 2008) and social skills (Yuan, Cheng, and Duan 2024; Franze, Galanis, and King 2023). More longitudinal research is needed to understand if this is a possibility when using smart speakers and how this outcome could be avoided. Further, researchers in this area recommended that an awareness of proportionate interactions with conversational technology is reinforced to prevent media dependence at the expense of quality human-human interactions (Yuan, Cheng, and Duan 2024). This will allow for smart speakers to be recommended as a safe and ethical intervention for social issues such as loneliness.

Further, while there is modelling research aiming to predict who will engage with smart speakers (Pitardi and Marriott 2021; Choi and Choi 2023), there is a lack of research aiming to predict who will perceive their smart speaker as a social agent and, thereby, gain social benefit from it. Further research could aim to produce similar models to understand who is likely to view their smart speaker as a social agent based on predictive factors known to be related to parasocial relationship development, such as isolation or loneliness (Andriani et al. 2023), attachment style (Cole and Leets 1999), or personality traits (Tsay and Bodine 2012; Wang, Fink, and Cai 2008), with subsequent development then possible to predict what type of relationship is likely to be perceived/develop.

This understanding of who is most likely to form social relationships with and derive social benefit from their smart speaker could then be used to improve interventions by selecting individuals most likely to benefit. This has cost-saving potential for groups such as housing associations who are seeking to maximise the benefit that can be achieved for the minimum cost. However, understanding who could benefit and offering them an intervention, such as a smart speaker, is not the same as ensuring those benefits can be achieved. Much research has been published examining how barriers such as lack of digital knowledge (Edwards et al. 2021) or privacy concerns (Brause and Blank 2023) influence the purchase of and engagement with smart speakers. However, there is little to no research on how similar barriers impact the potential for social benefit from these devices, and how these issues may be overcome through appropriate training or educational interventions. Consideration should be given to understand what support is needed for individuals likely to benefit from smart technology interventions to fully engage with the technology and reap the maximum possible benefits.

4.4. Conclusions

This scoping review highlights the growing ubiquity of smart speakers and the potential social and emotional impact these technologies can offer by facilitating parasocial relationships. By introducing the Parasocial Relationship Spectrum, we provide a framework for understanding the diverse ways users relate to smart speakers and classify their subsequent parasocial relationships. Our proposal of the ASAP Pathway offers a novel mechanism to explain how these relationships form, bridging insights from parasocial and human–computer interaction research. Additionally, we emphasise the need for long-term, targeted studies to fully assess the risks and benefits of smart speaker-based interventions, particularly for vulnerable populations. Future research should focus on refining and validating the ASAP Pathway to optimise smart speaker design and implementation for social well-being while minimising unintended consequences. By advancing theoretical understanding and practical applications, this study lays the foundation for more informed, ethical, and effective integration of smart speakers into social and therapeutic contexts.

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Appendix

Databases searched and search strings used on 2nd of February 2024 to identify literature relevant for this scoping review.

Database	Search query	Results
Web of Science	(AB = (‘google home’ OR ‘google assistant’ OR ‘google nest’ OR ‘amazon Alexa’ OR ‘amazon echo’ OR ‘amazon echo dot’ OR ‘apple Siri’ OR ‘apple Homepod’ OR ‘virtual assistant*’ OR ‘virtual home assistant*’ OR ‘virtual personal assistant*’ OR ‘digital assistant*’ OR ‘voice assistant*’ OR ‘voice enabled assistant*’ OR ‘voice enabled personal assistant*’ OR ‘voice interactive assistant*’ OR ‘voice interactive personal assistant*’ OR ‘voice initiated assistant*’ OR ‘voice initiated personal assistant*’ OR ‘voice powered assistant*’ OR ‘voice powered personal assistant*’ OR ‘voice operated assistant*’ OR ‘voice operated personal assistant*’ OR ‘voice activated assistant*’ OR ‘voice activated personal assistant*’ OR ‘voice controlled assistant*’ OR ‘voice controlled personal assistant*’ OR ‘voice controlled intelligent personal assistant*’ OR ‘voice interactive device*’ OR ‘voice interactive technolog*’ OR ‘voice interactive system*’ OR ‘voice interactive interface*’ OR ‘interactive voice assistant*’ OR ‘interactive voice technolog*’ OR ‘interactive voice system*’ OR ‘interactive voice interface*’ OR ‘artificial intelligen* assistant*’ OR ‘artificial intelligen* powered assistant*’ OR ‘smart speaker*’ OR ‘smart home speaker*’ OR ‘smart assistant*’ OR ‘smart home assistant*’ OR ‘conversational system*’ OR ‘conversational interface*’ OR ‘conversational agent*’ OR ‘conversational device*’ OR ‘conversational technolog*’ OR ‘conversational assistant*’ OR ‘intelligent personal assistant*’ OR ‘intelligent dialogue agent*’))AND AB = ((‘compan*’ NOT ‘companies’) OR ‘social$’ OR ‘friend$’ OR ‘lonel$’ OR ‘isolat$’ OR ‘buddy’ OR ‘pal’ OR ‘mate’ OR ‘relat$’)	813
ACM	[Abstract: ab =) OR [Abstract: ‘google home’) OR [Abstract: ‘google assistant’) OR [Abstract: ‘google nest’) OR [Abstract: ‘amazon Alexa’) OR [Abstract: ‘amazon echo’) OR [Abstract: ‘amazon echo dot’) OR [Abstract: ‘apple Siri’) OR [Abstract: ‘apple Homepod’) OR [Abstract: ‘virtual assistant*’) OR [Abstract: ‘virtual home assistant*’) OR [Abstract: ‘virtual personal assistant*’) OR [Abstract: ‘digital assistant*’) OR [Abstract: ‘voice assistant*’) OR [Abstract: ‘voice enabled assistant*’) OR [Abstract: ‘voice enabled personal assistant*’) OR [Abstract: ‘voice interactive assistant*’) OR [Abstract: ‘voice interactive personal assistant*’) OR [Abstract: ‘voice initiated assistant*’) OR [Abstract: ‘voice initiated personal assistant*’) OR [Abstract: ‘voice powered assistant*’) OR [Abstract: ‘voice powered personal assistant*’) OR [Abstract: ‘voice operated assistant*’) OR [Abstract: ‘voice operated personal assistant*’) OR [Abstract: ‘voice activated assistant*’) OR [Abstract: ‘voice activated personal assistant*’) OR [Abstract: ‘voice controlled assistant*’) OR [Abstract: ‘voice controlled personal assistant*’) OR [Abstract: ‘voice controlled intelligent personal assistant*’) OR [Abstract: ‘voice interactive device*’) OR [Abstract: ‘voice interactive technolog*’) OR [Abstract: ‘voice interactive system*’) OR [Abstract: ‘voice interactive interface*’) OR [Abstract: ‘interactive voice assistant*’) OR [Abstract: ‘interactive voice technolog*’) OR [Abstract: ‘interactive voice system*’) OR [Abstract: ‘interactive voice interface*’) OR [Abstract: ‘artificial intelligen* assistant*’) OR [Abstract: ‘artificial intelligen* powered assistant*’) OR [Abstract: ‘smart speaker*’) OR [Abstract: ‘smart home speaker*’) OR [Abstract: ‘smart assistant*’) OR [Abstract: ‘smart home assistant*’) OR [Abstract: ‘conversational system*’) OR [Abstract: ‘conversational interface*’) OR [Abstract: ‘conversational agent*’) OR [Abstract: ‘conversational device*’) OR [Abstract: ‘conversational technolog*’) OR [Abstract: ‘conversational assistant*’) OR [Abstract: ‘intelligent personal assistant*’) OR [Abstract: ‘intelligent dialogue agent*’) AND [Abstract: ab =) OR [Abstract: ‘compan*’) AND NOT [Abstract: ‘companies’) OR [Abstract: ‘social$’) OR [Abstract: ‘friend$’) OR [Abstract: ‘lonel*’) OR [Abstract: ‘isolat*’) OR [Abstract: ‘buddy’) OR [Abstract: ‘pal’) OR [Abstract: ‘mate’) OR [Abstract: ‘relat$’)	1148
Scopus	TITLE-ABS-KEY (‘google home’ OR ‘google assistant’ OR ‘google nest’ OR ‘amazon Alexa’ OR ‘amazon echo’ OR ‘amazon echo dot’ OR ‘apple Siri’ OR ‘apple Homepod’ OR ‘virtual assistant*’ OR ‘virtual home assistant*’ OR ‘virtual personal assistant*’ OR ‘digital assistant*’ OR ‘voice assistant*’ OR ‘voice enabled assistant*’ OR ‘voice enabled personal assistant*’ OR ‘voice interactive assistant*’ OR ‘voice interactive personal assistant*’ OR ‘voice initiated assistant*’ OR ‘voice initiated personal assistant*’ OR ‘voice powered assistant*’ OR ‘voice powered personal assistant*’ OR ‘voice operated assistant*’ OR ‘voice operated personal assistant*’ OR ‘voice activated assistant*’ OR ‘voice activated personal assistant*’ OR ‘voice controlled assistant*’ OR ‘voice controlled personal assistant*’ OR ‘voice controlled intelligent personal assistant*’ OR ‘voice interactive device*’ OR ‘voice interactive technolog*’ OR ‘voice interactive system*’ OR ‘voice interactive interface*’ OR ‘interactive voice assistant*’ OR ‘interactive voice technolog*’ OR ‘interactive voice system*’ OR ‘interactive voice interface*’ OR ‘artificial intelligen* assistant*’ OR ‘artificial intelligen* powered assistant*’ OR ‘smart speaker*’ OR ‘smart home speaker*’ OR ‘smart assistant*’ OR ‘smart home assistant*’ OR ‘conversational system*’ OR ‘conversational interface*’ OR ‘conversational agent*’ OR ‘conversational device*’ OR ‘conversational technolog*’ OR ‘conversational assistant*’ OR ‘intelligent personal assistant*’ OR ‘intelligent dialogue agent*’) AND ((‘compan*’ not ‘companies’) OR ‘friend$’ OR ‘lonel*’ OR ‘isolat*’ OR ‘buddy’ OR ‘pal’ OR ‘mate’ OR ‘social $’ OR ‘relat$’)	2074
Science direct	(‘google home’ OR ‘google nest’ OR ‘amazon Alexa’ OR ‘virtual assistant$’ OR ‘smart speaker’) AND (‘compan$’ OR ‘friend $’ OR ‘lonel$’ OR ‘isolat$’ OR ‘social$’ OR ‘relat$’)	806
Total including duplicates		4841
Number of duplicate articles removed		832
Articles remaining		4009