

Fart gags and prudish machines: Laughter in human-agent interactions

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ABSTRACT

We explore how laughter functions in in-the-wild human–Alexa interactions recorded in domestic settings. To do so, we analysed all instances of laughter in a corpus containing audio recordings from six households where an Alexa device had been newly acquired. The participants had no or very limited prior experience with voice assistants. Their interactions with Alexa were recorded over the first seven to ten weeks of use. Unlike previous HRI studies that primarily focus on dyadic, task-based exchanges, our analysis reveals that laughter in these real-world settings often emerges in multiparty interactions and serves a range of social functions beyond direct responses to the device. These observations highlight not only the need for ecologically grounded models of laughter in human–robot interaction, but also the value of linguistic and interactional analysis in uncovering the nuanced communicative roles laughter plays in everyday technology use. Such an approach allows us to identify how laughter signals both matches and mismatches in communication by marking alignment, managing breakdowns, and negotiating social meaning in interactions that often involve more than just the user and the device.

CCS CONCEPTS

• **Human-centered computing** → **User studies**; *Empirical studies in HCI*; *Field studies*.

KEYWORDS

laughter, human-agent interaction, laughter taxonomy, domestic, in-the-wild

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1 INTRODUCTION

Verbal communication between humans and robots has long been studied in the field of Human-Robot Interaction (HRI, see e.g., [57]), following an even longer tradition of studying verbal communication with other kinds of machines (see e.g., [49]). Spoken dialogue is often assumed to be an intuitive interface in HRI [42], and the development and investigation of HRI relying on natural language communication has recently been facilitated further due to advances in large language model (LLM) technology [21].

As voice assistants become increasingly embedded in everyday life, understanding how social signals function in real-world human–technology interaction is crucial. One aspect of language that is still understudied in HRI is laughter. Laughter is a deeply social phenomenon studied in human-human interaction for its different roles in interaction [23, 38]. Although the phenomenon is often associated with humour, several other social and communicative functions, such as emotional contagion [30], mimicry [14], and rapport-building [7], have been identified as well. To be able to rely on such functions, it is therefore important to study laughter in HRI contexts as well, including the contexts and situations where it naturally occurs. Increasing the focus on laughter in HRI might also highlight aspects of communication with robots that have thus far been overlooked.

In this paper, we will introduce and discuss observations from a corpus of natural domestic interactions between novice human users and Amazon’s Alexa EchoDot [2] with a specific focus on instances where laughter was present. In the context of natural interactions with conversational agents such as Amazon’s Alexa, questions arise as to whether laughter functions in the same way as in human-human interaction. To address this, based on a preliminary study [53], we begin by investigating existing taxonomies for laughter and assess how well they capture the instances of laughter we observe in our data set.

2 LANGUAGE AND LAUGHTER

Beyond words and grammatical structures, language functions as a dynamic instrument through which meaning is constructed, interaction is managed, and social relationships are negotiated [4]. In this light, laughter emerges not merely as a reflexive response, but as a communicative act that contributes to the coordination of interaction [12], the achievement of alignment [50], and the shaping of interpersonal connection [51]. Laughter is not just an automatic reaction to humour; it can often be used strategically in interaction and convey propositional content [11].

The circumstances under which we can produce laughter are affected by the perceived context and expectations of the interlocutors regarding possible changes of context. Ginzburg et al. [10] borrow the term *laughable* from Conversation Analysis [12] as denoting something that laughter *relates to* while being agnostic about whether it is humorous or not. Laughter performs a variety of functions: signalling non-seriousness (e.g., humour), managing turn-taking, and dealing with misalignment and misunderstanding [12, 18, 19]. Human interactions are organised and systematic, and many laughs serve as backchannels, which, either alone or together with other functions, can signal understanding of the previous utterance(s). Laughter has important, intrinsically social effects, being crucial for bonding and managing relationships, while also being immensely influenced by social context [39].

Importantly, laughter is contextually contingent [11, 12] and negotiated by participants. Even its identification as “laughter” is interactionally achieved—what may initially appear to be a sigh or breath can become a laugh simply through participant ratification. Laughter can therefore be misinterpreted and misunderstood, and itself be a subject of clarification requests, such as “why are you laughing?” [28]. People tend to unconsciously replicate the behaviours of their conversational partners (including laughter), a process referred to as non-conscious behavioural mimicry [23]. This tendency has been associated with fostering rapport and social affiliation.

2.1 Systematising laughter in human dialogue

Several attempts have been made to systematise laughter, and different systems highlight different aspects. Laughter can be produced simultaneously with speech (so called *speech-laughter*). Alternatively, laughter can be produced in isolation, i.e. it is not blended with the laughter’s speech (so called *laughter bouts*). Mazzocconi et al. [29] coded laughs depending on the level of “arousal” (intensity): Low, Medium and High. Another of their key ideas is a multi-level outlook on laughter: from its form and placement in relation to the laughable to its meaning [29]. Their taxonomy focuses on laughter functions (as in “the effect the laugher intends her/his laughter to have on the current dialogue”, [29], p.1309) and they use a decision-tree based framework to annotate laughs in various corpora. It takes into account four types of incongruity that characterise a laughable and groups the functions accordingly:

- Laughter functions associated with **pleasant incongruity** include showing enjoyment of a pleasant incongruity (e.g., laughing at a joke), and marking or recognising incongruity (e.g., to indicate absurdity of the situation which is otherwise not salient to others).

- Laughter functions associated with **social incongruity** include softening and trouble-telling (e.g., to accompany a criticism), benevolence induction (e.g., to accompany self-criticism), smoothing and showing sympathy.
- Laughter functions associated with **pragmatic incongruity** include marking irony, scare quoting, lexical enrichment and lexical uncertainty.
- Laughter functions that are **not related to any incongruity**, including the demonstration of friendliness and affiliation.

The authors of the taxonomy offer a critical analysis of previous research that disproportionately emphasises humour as the primary trigger for laughter, and earlier studies by Provine [38] have already indicated that a substantial amount of laughter occurs in response to everyday remarks. This evidence suggests that laughter often functions as a marker of social and interactional processes and is not exclusively an expression of amusement but part of the ongoing management of matches and mismatches in dialogue.

Additionally, as proposed by Koutsombogera and Vogel [22], laughter in dialogue can be categorized as either *discourse laughter* or *mirthful laughter*. Discourse laughter includes elements such as politeness markers, acknowledgments, and fillers that support conversational flow, often occurring during topic transitions. Mirthful laughter, on the other hand, reflects spontaneous responses driven by amusement. The two kinds of laughter are therefore fulfilling different purposes in the interaction, with discourse laughter playing a larger part in the structuring of the interaction [22].

Although Mazzocconi et al. offer a pragmatically grounded taxonomy of laughter, it is based on human–human interaction and may not reflect the specific dynamics of interaction between humans and non-humans [29]. It is therefore possible that there are context specific aspects in interaction with non-humans that become invisible or overly highlighted if studied through a lens specifically developed for human–human interaction. This is a risk to be aware of when transferring methods and tools from one domain to another.

2.2 Laughter in HRI

Although laughter has been widely studied in human–human interaction, its role in human–agent dialogue remains less clearly defined. One branch focuses on human laughter, for instance using computational methods to assess and classify laughter in HRI based on the sound patterns in human laughter [34]. The other strand focuses on machine-generated laughter, for instance using hidden Markov models to improve the laughter synthesisers for robots based on human laughter [52].

Other studies highlight the function of laughter in HRI as a key social cue for bonding, emotional involvement, or even moments of discomfort and repair. For example, the timing of robot generated laughter and its congruency with the robot’s gaze patterns have been shown to affect how humans experience robots in terms of perceived empathy, naturalness, and compassion [8]. Further, the phenomenon of shared laughter between humans and robots has been studied, with the goal of allowing the robot to recognise and respond to user laughter in ways that support more socially aware and empathetic dialogue [16]. Laughter has also been investigated

as a strategy to improve communication, for example while robots tell stories [48], or to help conversations feel more natural [17].

When laughter is addressed in HRI, it is, however, often done in relation to humour, another topic with a small but growing interest in HRI [33]. Humour has, for instance, been studied in terms of robots telling jokes [3, 54], but has also been proposed to have other functions, such as constituting a viable strategy for a robot to recover after a failure [13]. The physical embodiment, and the motions and gestures their embodiments allow for, has also been identified as a particular factor to study to better understand humour in HRI. Several studies have focused on recreating human behaviours and gestures in humorous situations or while laughing [8, 17], but there are also examples of studies on designing appropriate gestures specifically for the particularities of individual robot designs [37]. Demographic factors have also been identified as relevant variables to consider when investigating humour and laughter in HRI [1, 26].

To systematically study instances when humans laugh in interactions with voice-controlled virtual assistants (VA, for example Amazon's Alexa), a taxonomy has been created for this particular context [34]. It focuses largely (but not exclusively) on humour due to different kinds of mistakes by the machine. Due to the limited physical presence (and lack of body parts) of VAs, the taxonomy accounts for the absence of typical social cues like gaze and gesture. Their taxonomy includes six laughter contexts, drawn from real usage data, and evaluated in experiments where users were asked to record themselves while having 10-minute conversations with an Alexa. Their laughter contexts are:

- **Text-to-Speech (TTS) / Automatic Speech Recognition (ASR) error:** laughter triggered by technical mistakes, such as Alexa mispronouncing names or misrecognising user input.
- **Discourse atypicality:** laughter arising from pragmatically odd or unexpected responses. This includes inappropriate content (e.g., calling someone's name to be suitable for a dog), too-human content (e.g., implying a shared social future), and abrupt topic changes.
- **Timing error:** laughter caused by awkward interruptions or long silences, disrupting the conversational flow.
- **Humorous statement:** intentional jokes or light-hearted responses by Alexa that elicit laughter.
- **Conversation end:** laughter at closure, often as a politeness marker or to signal a friendly goodbye.
- **Post-own speech:** laughter following users' own remarks, usually for self-deprecation or hedging.

These annotated categories emphasise the range of triggers for laughter in human-VA interactions, many of which deviate from traditional humour-based accounts. In fact, the majority of laughter in their data is not from jokes or humorous content, but from interactional mismatches, design limitations, or awkward responses [34]. The authors identify that laughter in human-VA interactions frequently follows instances of discourse anomalies, paralleling observed behaviours in adult-adult and mother-child interactions [27]. This phenomenon lends support to technology equivalence theories, which, much like the computers are social actors (CASA) paradigm [32, 41], state that users transfer social

norms from human-human interactions to their interactions with technology [15, 46]. Interestingly, the frequency of laughter in these interactions is markedly lower than that in human-human exchanges, with instances of laughter being predominantly brief and lacking vocalisation. One explanation for this discrepancy lies in users' expectations about AI systems [45], specifically the assumption that Alexa neither produces nor responds to laughter, which may lead users to adjust their own behaviour accordingly.

The focus of previous research has largely been on dyadic interactions in controlled experimental settings. Although there is much to learn from such studies, they are not always representative of the situations in which robots are intended to be used. In the following section, we introduce and discuss a mundane domestic setting which exemplifies situations which are not sufficiently covered by the taxonomies of the experimentally studied dyads.

3 MUNDANE INTERACTIONS IN DOMESTIC SETTINGS

While the number of social robots deployed in society is still quite low [58], one of the exceptions to this can be found in voice-controlled virtual assistants, such as Amazon's Alexa EchoDot (Alexa). These kinds of virtual assistants are often integrated into smart homes, and only physically embodied in the sense of inhabiting an immobile speaker/microphone with some additional LED-lights to signal with. Verbal communication is thus the primary mode of interaction between VAs and humans, and they are by design intended to be integrated into the users' mundane domestic everyday life. How and whether results for interaction with VAs can be generalised to interaction with other kinds of technology is, however, not trivial. Studies have indicated that VAs might generally provide more pragmatic, but less hedonic, values compared to more anthropomorphic robots [35, 47], though individual differences and many other factors seem to have a large impact when making such comparisons [25, 31]. Which specific kinds of results are transferable between these types of agents (and to what extent) is therefore still an open question and in need of further investigation to better understand how different kinds of physical and social presence might impact the perception of artificial agents. It has, however, previously been shown that the introduction of artificial agents in domestic settings might disrupt social dynamics and behaviours [6], making it particularly important to study the potential impact of the deployment of such systems.

Given the relative prevalence of VAs as social artificial agents in domestic environments, they serve as an interesting test case for social interaction (in which laughter plays important roles) with artificial agents. There are many ways to study such interaction, however, given the importance of contextual and situational factors for communication in general, and for laughter in particular, it is important to complement controlled experimental studies (e.g., [34]) and studies relying of self-reports (e.g., [24, 40]) with unscripted "in-the-wild" observations [20]. Mundane situations and domestic settings can be complex and messy. However, rather than "cleaning up" these situations and only focusing on ideal cases, it is important to also include the mess [5, 44]. Engaging with the less ideal, but more natural, aspects of the situations, including complications and outliers, will not only provide studies with higher ecological

validity, but also highlight aspects that might otherwise be invisible in the literature.

3.1 The Barthel corpus

To investigate the role of laughter in human-robot interaction in-the-wild, we have analysed all instances of laughter in the corpus presented by [2]. The corpus, on which this analysis is based, contains sound recordings from six German households, with the recording periods starting when the Alexa was first installed in the households. The recorded participants were interested in getting a VA for their homes, but did not have any significant amount of prior experience of using such systems. The participants' interactions with the Alexa were recorded for the first seven to ten weeks of use, for which the participants received a small amount of financial compensation as well as being allowed to keep the Alexa after the recording period. All participants had been informed about the study, including instructions on how to mute the devices for privacy. The data from Amazon was requested by the participant, and then forwarded to the researchers collecting the corpus, allowing the participant to remove any potential instance with sensitive data (see [2], footnote 6). All participants consented, and there are occasions where the device has been muted, but there are no instances where the participants requested to have any material removed. In addition to the household members, the material also contains some occasional visitors. In those cases, the participants informed their visitors about the study and asked them to consent as well, otherwise muting the device while the visitor was there.

The Alexa was installed in either the kitchen or living room of the respective households, together with a secondary recording device (developed and used by [36]) that recorded three minute sound snippets centred around Alexa's wake-word (storing the sound from 90 seconds before 'Alexa' is uttered to 90 seconds after). The recorded material was later transcribed and annotated. In the material, 135 instances of laughter can be heard. Four of the households produced between 18–53 instances of laughter each, no laughs were produced in one of the households (in which the Alexa was barely used), and the data from the last (single member) household was excluded from the dataset since they did not fit the criteria of being a first time user, nor were they a native German speaker.

Only the four households in which laughter was detected were analysed, and they are summarised in Table 1. The households consisted of two to four members, and the average age was 32 years for the adults and 6 years for the children.

3.2 Methods for analysis of laughter instances

To be able to investigate laughter in interactions between humans and Alexa, we annotated all the detected instances of laughter based on the taxonomy proposed by [34]. This annotation was done independently by two of this paper's authors. After the instances from the first household was complete, the two annotators conferred about their experience to make sure that they were consistent in how the task and taxonomy was interpreted. The instances from the final three households were then annotated without any adjustments by the same annotators. In addition to assessing which

category in the taxonomy each instance belonged to, notes regarding general reflections were recorded.

4 THEMES OBSERVED IN THE CORPUS

It quickly became clear for the annotators that the taxonomy of [34] was not actually appropriate for this context, despite being designed for analysis of human laughter when interacting with VAs like Alexa. The main reason for this is likely to be found in the difference in contexts (the speaker being instructed to have a 10-minute conversation [34] compared to spontaneous interactions in a domestic everyday setting [2]). The annotators had only a fair inter-rater reliability ($\kappa = 0.29$) indicating problems of fitting the data to the taxonomy. Nonetheless, interesting aspects of this annotation were found in the reflections related to how the taxonomy failed to handle the instances of laughter in this corpus, most of which either weakly belonged into several categories or needed entirely new categories. While the material is quite rich, and highly ecologically valid, the instances of laughter are still too few to make strong claims. However, the instances are sufficiently many for several themes to emerge, mainly through compiling the annotators' notes on what they found difficult with categorising each instance, or what they found characteristic of each instance. The deductive approach in the initial part of the analysis could thus, apart from highlighting some patterns, generate thoughts that later facilitated the more inductive approach to the corpus. This work was done iteratively, and also involved some of the co-authors who had not participated in the coding, facilitating critical scrutiny of the annotation.

4.1 Results from the taxonomy

When the annotators attempted to annotate the instances of laughter in the corpus (according to [34]), the most common annotation was to not be able to assign it to any category, despite the annotators trying to go with the most reasonable when there was a bad fit (however, one annotator was more keen to force the instances into a category, resulting in 35% and 50% of the instances being unclassified for the respective annotators). Even among the actually annotated instances, it is rare to not also have a comment regarding it being a bad fit and likely fitting (almost) equally well in one of the other categories. The most common category used from the taxonomy was that the laughter was triggered by some kind of technical issue with the speech recognition or generation, and this category was used for almost 20% of the instances. Another category with an average of roughly 20% of the annotations (although with larger discrepancies among the annotators) was that the laughter was related to a joke. This was a category that would have been rarely used by either annotator if a stricter interpretation would have been used, as most of these instances were more related to light-hearted or informal statements (discussed more below). Another category worth mentioning despite being used for less than 10% of the annotations was the category of atypical discourse. This was often mentioned in both annotators notes as a potential alternative, or a category that almost fit, but ultimately was not used much since it would have required an overly relaxed interpretation.

Due to these difficulties of making sense of the data based on the existing human-Alexa interaction taxonomy, our reflections on the

Table 1: Summary of the participants in the four analysed households in terms of their respective roles, pronouns, and ages. Their respective ages are expressed in years, “Commands” refer to how many total commands were uttered to Alexa in the respective households, and “Laughters” refer to the number of those situations where any laughter was detected.

Household	Participants	Age	Commands	Laughters
CVR03	mother (she), son (he)	35, 5	503	26
CVR07	mother (she), father (he), son (he)	27, 27, 6	818	38
CVR08	couple (she, he)	27, 34	218	18
CVR09	mother (she), father (he), son 1 (he), son 2 (he)	37, 37, 8, 5	900	53

data analysis are discussed in the three upcoming subsections under the headings “errors and jokes”, “participation in the interaction” and “functions of laughter”.

4.2 Errors and jokes

The cases where the laughter did fit the taxonomy [34] and there was clear agreement between the annotators were typically either due to a TTS/ASR error, or due to a humorous statement by the Alexa. These instances are often situations where the Alexa fails to recognise some instruction (often several times), which leads to the people present starting to laugh and joke about the situation. Consider the following example from household CRV03, where users try to turn down the volume of the device after requesting to play a game:¹

ADULT: Alexa leiser.
(Alexa quieter)
 ALEXA: Die Drei Fragezeichen [Dein -]
(The Three Investigators Your -)
 ADULT: [Alexa] leiser. leiser. leiser.
(Alexa quieter quieter quieter)
 ALEXA: Das habe ich leider nicht verstanden.
(I did not understand that, unfortunately)
 SPEAKER: [Al-]
 ALEXA: [Die Drei] Fragezeichen: Dein Fall
(The Three Investigators: Your Case [(.)])
 CHILD: [((snort laughter))]
 ALEXA: ist mit 3,5 [von mehr als] -
(is with 3.5 by more than -)
 ADULT: [Alexa?] leiser.
(Alexa quieter)
 ALEXA: Die Drei Fra[gezeichen] -
(The Three Investigators -)
 ADULT: [Alexa?] leiser.
(Alexa quieter)
 CHILD: [((giggle))]
 ALEXA: Die Drei Fra[gezeichen] -
(The Three Investigators -)
 ADULT: [Alexa?] leiser.
(Alexa quieter)
 ALEXA: [Die Drei Fra-]
(The Three Inves-)
 CHILD: [Alexa]
 ADULT: leiser.

¹Overlapping material is shown in square brackets. English translations of the utterances are written in italics under the German originals.

(quieter)
 ALEXA: Die Drei Fragezeichen Dein Fall ist mit 3,5 von mehr als
 [5600] -
*(The Three Investigators Your Case is with 3.5 by more than
 5600 -)*
 ADULT: [Alexa?] leiser.
(Alexa quieter)
 ALEXA: Die Drei Fra[gezeichen] -
(The Three Investigators)
 ADULT: [Alexa?] bitte sprich leiser.
(Alexa please speak quieter)
 ALEXA: Das habe ich leider immernoch nicht verstanden. [Ich
 kann aus -]
(Unfortunately, I still did not understand that. I can -)
 ADULT: [Alexa?] bitte leiser.
(Alexa please quieter)
 ALEXA: Das habe ich leider nicht verstanden.
(I did not understand that, unfortunately.)
 CHILD: ((laughter))
 ADULT: «smile voice» Alexa leiser.> (([laughter])) (Alexa quieter)
 CHILD: (([laughter]))

Given that we did not find any instances of laughter when users interacted with the device without any other human present, it is conceivable that, had these situations been dyadic, with only one human present, the situation would likely have been met with frustration rather than laughter. However, to be more certain about this point, we would need to compare similar situations in solitary use.

In case of the humorous statements, an improved taxonomy would benefit from more sub-categories, as there was a large variety in how and why the statements could be considered humorous. There were, for instance, examples of the Alexa telling a joke that the users laughed at. In our corpus, it is quite rare that the jokes that Alexa tells cause laughter. There are, however, instances where the Alexa evoked laughter by refusing to tell dirty jokes (for example in household CVR08). The laughter was likely due to the unexpected interaction that followed, where the user and the Alexa accused each other of being prudish. Rather than being directly caused by the joke telling, the laughs seem to come from answers that are more casual or light hearted. Such interaction could, at surface value, potentially be considered part of the troubling sexist patterns built into, or facilitated by, technology reported in [55]. However, this sequence was part of a larger interaction where the user is playfully exploring the guardrails put in place as a reaction to [55]. In this case, the Alexa tried to avoid the subject in a low-affective way,

though other strategies have been proposed (e.g., [56]). Whichever strategy is used, it is likely that some users will be curious and explore what kind of responses different inputs could prompt.

The topic of Alexa potentially being a prude followed from the conversation below between a speaker and Alexa, with another human present in the room. Before the speaker's first question to Alexa, the two humans (who are the residents of the household) had a conversation leading up to the question. Between this interaction and the request for dirty jokes, the humans were discussing the potential reasons for the responses. The asterisks (*) mark lines that are not directed to the Alexa, but part of the conversation between the humans.

SPEAKER 1: Alexa was ist die beliebteste Sexstellung?
(Alexa what is the most popular sex position?)
 ALEXA: Das weiß ich leider nicht.
(Unfortunately, I don't know.)
 SPEAKER 1: ((laughter)) Das ist nicht dein Ernst!
(You can't be serious!)
 SPEAKER 2: *((laughing)) So witzig, die ist so prude.
*(*So funny, she's so prudish.)*
 SPEAKER 1: *Ja.
*(*Yes.)*
 SPEAKER 2: *Frag mal ob die prude ist.
*(*Ask if she's prudish.)*
 SPEAKER 1: Alexa bist du prude?
(Alexa, are you prudish?)
 ALEXA: Nein, ich bin nicht prude. Du?
(No, I'm not prudish. You??)
 SPEAKER 1: ((laughing)) Nein.
(No.)
 SPEAKER 2: *So witzig.
*(*So funny.)*

Some of the laughs in humorous situations seem to be due to a surprising mismatch in some expectation. In the example above, the user found the response overly formal and serious, but there are examples of the opposite as well, where users may assume that the Alexa will remain formal but it responds in a surprisingly casual way (e.g., a user said “good night” and the Alexa responded with the very colloquial “Snächtle”). Some other examples of unexpected behaviours that prompted laughter are when Alexa gives unexpectedly elaborate answers (e.g., providing surprising amounts of detail on the wealth of the cartoon character Scrooge McDuck) and when providing answers with surprisingly human aspects in them (e.g., answering the question “Alexa, how old are you?” with “I am eight years old. This is much more mature for an artificial intelligence than for a human!”). All of these commands happened to come from household CVR08, in which the members often probed Alexa and talked and laughed amongst each other regarding the results.

Another example of laughs which would be categorised as being due to humorous statements occurred when surprising and light-hearted features were discovered (e.g., if a user says “Alexa, I love you” it will play a specific jingle as a response). The function of Alexa's jingle was discovered by one of the children in household CVR09, and the children in this household triggered this feature several times more after the discovery.

4.3 Participation in the interaction

One observation that stood out was that all instances of laughter in the corpus included more than one human. It was either the case that several humans were part of the interaction with the Alexa, or there were other humans physically present (sometimes in a neighbouring room) and the laughter seemed to be a call for attention to the other human (e.g., when a user discovered a new feature, or when the Alexa said something unexpected or witty). Consider the following sequence from household CVR08 as an example:

SPEAKER 1: Alexa?
 SPEAKER 2: Was?
(What?)
 SPEAKER 1: Bin ich zu dick?
(Am I too chubby?)
 ALEXA: Solange du dich wohl fühlst bist du perfekt wie du bist.
(As long as you feel comfortable you are perfect as you are.)
 SPEAKER 1: ((laughter))
 SPEAKER 2: *Was?
*(*What?)*
 SPEAKER 1: *Ich hab Alexa gefragt ob ich zu dick bin.
*(*I asked Alexa whether I'm too chubby.)*
 SPEAKER 2: *Und?
*(*And?)*
 SPEAKER 1: *Solange ich mich wohl fühle bin ich perfect so wie ich bin.
*(*As long as I feel comfortable I am perfect as I am.)*
 SPEAKER 2: *Das ist aber schön.
*(*That's nice.)*

Another example is an instance when several children in household CVR09 are playing with the Alexa, partly by making it playing different kinds of fart noises (at which the children are laughing). The commotion prompts an adult to enter the room to check on the children and start to laugh at the situation.

This highlights another important aspect; the situations in which laughter is produced is often quite complex and dynamic. Who is involved (e.g., Alexa and various humans), in which role they are involved (e.g., a conversation partner or artefact in the environment), and what the laughter is directed at (e.g., at the Alexa, at a statement made by the Alexa, or at the interaction itself) will all affect the laughter as well as the situation in which it takes place. These factors can, however, often change quickly throughout the interaction, sometimes in the sense that a human can switch from having a conversation with the Alexa to interacting with another human as they entered the room.

Due to the fluidity of the roles of the agents in the situation, and how Alexa in particular can seamlessly shift back and forth between being an interlocutor and a background object, while still impacting the situation and the human-human interaction, the domestic use cases we investigated fit well within the perspective of Interaction-Shaping Robotics (ISR) [9]. This perspective acknowledges and emphasises the (short-term and long term) impact of robots in a situation that goes beyond the traditionally more common views of focusing on the direct interaction between the different agents. Although potentially more complex to study, our observations from the domestic use of Alexa highlight the need for ISR to inform

better designs of robots intended for broad and mundane use, as well as to improve the understanding of what kinds of impact the introduction of artificial agents can have.

4.4 Functions of laughter

Another, yet related, aspect is that the purpose of the laughter can vary, much like the purpose of other kinds of utterances. There are times when the laughter is related to humour and times when it provides social cues to interpreting utterances. There are also instances where users were giggling out of excitement, and times when the laughter was a response to finding a statement by the Alexa cute.

The reason for interacting with the Alexa can be (much like other interfaces with technology, [43], pp.47–54) to instruct (e.g., “Alexa, play me a song”), to converse (which is more similar to dialogue where the participants respond to each other), to manipulate (which is rare given the virtual nature of most aspects of the Alexa), and to explore (e.g., where features are tested to see if they work). However, an important kind of interaction that contained laughter does not neatly fit in any of those categories and deserves a category of its own, namely *play*. This is the type of interaction where interactants (of all ages) go out to test the technology or probe how Alexa would answer. These interactions produced a generous amount of laughter tokens in our corpus not neatly fitting into any previous categories.

For instance, a child speaker in household CVR09 said “Alexa, du bist die hübscheste Frau der Welt!” (*Alexa, you are the prettiest woman in the world!*) out of the blue. During this instance, there are several children and an adult in the room, and they take turns asking questions and the children are generally giggling throughout the interaction. Alexa’s answer, “Danke! Als K.I. habe ich kein Geschlecht—aber über das Kompliment freue ich mich trotzdem.” (*Thanks! As an A.I. I don’t have a gender—but I’m still happy about the compliment.*), triggered a predictable laughter. Many other examples were about inquiring about the nature of Alexa—questions such as “Alexa, hast du ein Gesicht?” (*Alexa, do you have a face?*) or “Alexa, hast du ein Gehirn?” (*Alexa, do you have a brain?*).

Playful behaviour can be observed while users are, for instance, instructing or exploring, but many of the playful instances were rather joint activities among humans, in which the Alexa played a more or less direct role. There were, for instance, situations where two humans were competing about what song to play or the volume level of the output, as in the following example from household CRV03:

ALEXA: ((*playing music*))

SPEAKER 1: Alexa leiser.

(*Alexa quieter*)

ALEXA: ((*playing music on lower volume level*))

SPEAKER 2: Alexa lauter

(*Alexa louder*)

ALEXA: ((*playing music on initial, higher volume level*))

SPEAKER 1: Alexa leiser.

(*Alexa quieter*)

SPEAKER 2: «laughing» Alexa lauter.))

(*Alexa louder*)

A typical interaction in those instances consisted of one user instructing the Alexa to play a song (which it did), while another

user instructed the Alexa to switch to another song (this behaviour could repeat several times). The interaction was complemented with laughter and attempts to sabotage each others attempts to instruct the Alexa. This situation could potentially (albeit awkwardly) be understood as two dyadic interactions (between each human and Alexa, respectively), but a more appropriate way could be to see it as an interaction between the users that was mediated, or facilitated, by the Alexa. This kind of playful situation appears to fall into the pleasant incongruity category according to Mazzocchi et al.’s taxonomy [29], which is under-represented in [34], although this requires diligent annotation, which we are planning to undertake in future work.

The more playful and casual situations might be particularly important to consider in these cases, given the domestic setting. The Alexa is intended to be a VA to use casually and informally, simply by calling to it without approaching it. This is similar to how some of the users were calling and talking to each other even when they were attending different tasks or inhabiting different rooms. The users could more or less seamlessly flow in and out of a joint activity (conversation), and the Alexa was often treated in a similar way. Even though it was common for users to speak to the Alexa directly, it was also common to “talk behind the back” of the Alexa in front of it (see e.g., the second example in section 4.2), likely knowing that it would not respond without being addressed directly. When users were using the Alexa, it would often dynamically be included and excluded from the joint activity from utterance to utterance. This phenomenon was also observed with the laughter, where humans could laugh as part of the interaction with Alexa, but could also laugh at Alexa as if it was not there. This switching between including or excluding Alexa in the laughter could happen very quickly and seamlessly.

5 LIMITATIONS AND FUTURE WORK

There are several limitations to be aware of to appropriately interpret our results. The data were collected from a small number of households (resulting in a fairly small number of instances of laughter) in Germany, meaning that results can be sensitive to noise and that the data are grounded in a German cultural context and based specifically in domestic, multi-person environments. Since the data were collected over a span of roughly two months, and the participants were interested in this kind of technology while only having limited prior experience, the corpus is well suited to investigate the dynamics in interaction as novelty effects wane and expectations change. Due to the small number of households, and relatively few instances of laughter, it is difficult to draw conclusions with great certainty and generalisability. There are too many potentially relevant other factors that are likely to impact the laughter in these interactions. In addition, it is also difficult to predict to what extent our observations can be generalised to other kinds of artificial agents. Especially to more substantially embodied social robots, that might be able to utilise body language and wield a stronger physical presence. Collecting more data in the future would facilitate a better understanding of the phenomena discussed in this paper. However, given the range of variation and

complexity of mundane domestic situation, it is unlikely that quantitative methods would ever be sufficient on their own for this kind of context.

Despite these limitations, the data are rich and highly ecologically valid. The observed themes can be investigated and validated in targeted future studies to identify to what extent these insights can be transferred to other contexts. In addition, we intend to systematically analyse the material further, with the purpose of constructing a taxonomy for analysing laughter in this kind of context, that is, in mundane in-the-wild situations, potentially with several agents participating in the conversation simultaneously. We not only see the need for additional categories of laughter, but also a way to capture some of the relevant context and dynamics. For example, highlighting which agents (and in what roles) are involved in the interaction, what the laughable is, and what the function of the laughter is, are all relevant factors to capture. Defining such a taxonomy that allows for a succinct annotation schema would be preferable as it would allow for analyses of laughter (or lack thereof) in ways that would facilitate explainability of the robot behaviour. Such future work is also expected to facilitate a better understanding of the limitations, relations, and utility of the various existing related taxonomies.

6 CONCLUSIONS

We have investigated laughter in mundane, domestic HRI situations through in-the-wild recordings collected in participants' homes over a period of several weeks. Some key features we have observed in the data we analysed are that laughter typically requires several humans to be present, the instances of laughter are socially complex, with a large variety in participants, roles, and targets, and the laughter could fulfil several different purposes. Further, the laughs in our observed interactions are often meaningfully different than laughs in interactions with only humans. Existing taxonomies for annotating laughter do not completely cover the observed instances, and further research is needed to better understand these interactions. It is particularly important to fundamentally include situational and social aspects when investigating these situations. Investigating laughter in the first place is particularly relevant as it plays an important part in communication and social interaction, while mainly being studied in the context of comedy. To better understand communication and social interaction, and design artefacts to be part of such activities, it is necessary for laughter to be investigated in a broader and more complex sense. This paper shows how laughter is integrated in complex, yet mundane, domestic situations that contain a VA.

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