# The Changing Nature of Childhood Environments

## Investigating Children's Interactions with Digital Voice Assistants in Light of a New Paradigm

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*Abstract* — **Based on the theoretical framework of the New Ontological Category Hypothesis (NOCH), this piece of doctoral research (work in progress) investigates the nature of children's interactions with commercial Digital Voice Assistants (DVAs), such as Alexa, Google Assistant, or Siri. In a nutshell, NOCH challenges the notion of anthropomorphism and argues that intelligently behaving machines, such as voice assistants, could become ontological categories in their own right within children's emerging understanding of the world. A methodological strategy is briefly outlined in order to explore NOCH with respect to children's relative self-disclosure, that is, how children self-disclose personal insights when they interact with DVAs, on the one hand, and humans, on the other hand.**

***Keywords – voice assistants; children-machine interaction; anthropomorphism; cognitive development; mixed methods.***

## I. INTRODUCTION

The spread of commercial Digital Voice Assistants (DVAs), such as Apple's Siri, Amazon's Alexa, or the Google Assistant, has gained extreme momentum within a few years, not only in terms of total numbers (i.e. number of households using DVAs), but also regarding individual usage intensities (i.e. number of DVA-devices per household), or third party developers that enter the DVA-market [1][2]. Although today's DVAs are neither the only nor the most sophisticated manifestations of Artificial Intelligence (AI) in everyday life, these automated voice interfaces still remain one of the most tangible and recognizable embodiments of humanoid artificiality, and they are often present within the most intimate spaces of our home environments.

Although empirical insights regarding the nature of child-DVA interactions remain limited up to this point, a popular implicit or explicit theme in the growing body of preliminary research as well as journalistic commentaries is the anthropomorphism paradigm [3]–[8], which assumes that, as part of our human nature, we are sometimes inclined to treat and perceive non-human entities through a humanoid lens, either consciously or sub-consciously [9]–[12]. In the context of child-DVA interactions, this notion often translates into the general idea – not to say fear – that these machines could become children's 'imaginary' friends (e.g. [13]). But the question remains: How much imagination is required when you talk to DVAs? The short answer is *none*, because the fact that you talk to Alexa *et al.* is as real as the fact that an actual humanoid voice responds to your request. In addition, claiming that children's interactions with DVAs, in particular, and humanoid AI, in general, can be conceptually reduced to anthropomorphic behaviours and imaginative perceptions also means to ignore that children's cognitive development might give rise to unprecedented forms of understanding and perception when it comes to the human-machine interactions.

Hence, this piece of doctoral research, as it is outlined in this paper, argues that the anthropomorphism paradigm is not sufficient to grasp the evolving interactive relationship between children and DVAs on scientific grounds. Instead, the New Ontological Category Hypothesis (NOCH) by [14] is proposed as an alternative and exemplified in the contemporary context of DVAs. Lastly, a methodological strategy for its empirical investigation is briefly outlined.

This paper is organised as follows: Section II briefly introduces the anthropomorphism paradigm and explains its theoretical implications. Section III raises major criticisms and shortages of the anthropomorphism paradigm in the context of child-DVA interactions. Section IV proposes and explains NOCH as an alternative paradigm. Section V concludes the discussion before the next steps for future research are outlined in the last section, Section VI, of this paper.

## II. ANTHROPOMORPHISM: AN OVERVIEW

A prevailing paradigm in human-machine interaction and related disciplines is anthropomorphism, arguing that our behaviours and perceptions that characterise interactions with other humans can also be present when we interact with non-human entities, such as machines. This section briefly summarises anthropomorphism's theoretical substructure and implications, before turning the reader's attention towards its shortages in the next section.

### *A. Origins and mechanisms of anthropomorphism*

The human inclination to project some essence of humanness onto non-humanness, as firstly pointed out in early scholarly work by Charles Darwin, David Hume, or Sigmund Freud, remains a widely observable and reported phenomenon across different entities (e.g. animals, objects, or supranatural beings), and, of course, with varying degrees of prevalence and intensity throughout different historical, cultural, situational, and individual contexts [11][12]. Ever since the emergence of modern consumer technologies in the 20th

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century, this anthropomorphism paradigm has served as a popular framework to conceptualise those empirical observations in which human interactions with machines and media seemed to follow certain patterns of intra-human behaviours and perceptions (e.g. [9][15][16]).

When it comes to the underlying psychological mechanisms that supposedly drive this widely observable inclination of human nature, anthropomorphism has been explained as an inductive inferential process: when we encounter a non-human entity with an uncertain or ambiguous inner state of being, we attempt to imbue its opaqueness with our introspectively acquired certainty about human life and mentality by adjusting our behaviour and perceptions as if it was human [11][12]. Notably, this process can already be present during infancy and early childhood, when children project their inner idea of human life and mentality – even though these ideas might still be pre-mature from a developmental perspective – onto the objects they play with, often according to their vivid imaginations and fantasies, which is referred to as 'pretend play' or 'behaving-as-if-play' [10].

### B. Extending anthropomorphism: a thought experiment

It must be emphasised that for children as well as adults anthropomorphism is not necessarily about confusing human and non-human entities; instead, it is about the creative control that is exercised over an entity that offers sufficient space for projection [10][17]. Hence, the reason why it would not make any sense to apply anthropomorphism to intra-human interactions is because, theoretically speaking, there is no space when one attempts to project humanness onto something that *is* indeed human. In other words, it would be odd to argue that when we interact with each other we do behave as if we were human, because, strictly speaking, we *are*.

This yields an interesting theoretical thought experiment: if we extend the basic notion of anthropomorphism, one reasonable implication – similar to the reasoning of the original Turing Test [18] – would be that human interactions with machines should become more humanlike as technology develops, all the way up to the (theoretical) stage of perfect resemblance when AI would be able to emulate all domains of human intelligence. At this (theoretical) stage – which would also go beyond a potential uncanny valley – the anthropomorphism paradigm would suggest that human-machine and human-human interactions follow (almost) indistinguishable patterns. Interestingly enough, this idea of 'perfect anthropomorphism' matches the notion embedded in most pop cultural future visions that became famous throughout the 20th and 21st-century, such as the supercomputer 'HAL 9000' in Stanley Kubrick's masterpiece '2001: A Space Odyssey', the crime-fighting car 'Kitt' in the TV-show 'Knight Rider', or, most recently, the charming virtual girlfriend 'Samantha' in Spike Jonze's science-fiction romantic drama 'Her'.

However, even today, while we still wait for general AI and humanoid supercomputers to arrive (or not), the anthropomorphism paradigm and its theoretical implications seem problematic for several reasons, which are discussed in the next section.

## III. Challenging Anthropomophism

This section challenges anthropomorphism with three points of criticism related to its theoretical substructure as well as its applicability in the context of DVAs.

### A. The appreciation of non-human qualities

The first general point of criticism against anthropomorphism is that, due to its simplistic theoretical substructure, it fails to consider an important aspect, namely how we as humans might appreciate machines due to their non-human qualities – and not despite of them. In other words, instead of arguing that our interactions with machines will become more intimate and intense as we see more humanness in them, the opposite could be true, because we might prefer machines over humans whenever we appreciate certain aspects about their inner absence of humanness.

For instance, since the early 1970s, an extensive body of clinical research has shown how patients are more willing to self-disclose personal insights to a computer rather than a human physician [19]–[23], and a comprehensive meta-analysis confirmed this tendency of humans to self-disclose more personal insights through a computer interface compared to face-to-face interviews [24]. Furthermore, more recent research has been able to extend these findings to virtual agents, which were often able to establish higher levels of rapport and elicit more personal insights from participants compared to the human baseline condition [25]–[27]. Another very recent piece of experimental research has shown that, across different domains of intelligence, participants prioritised predictions and assessments that were labelled to be of algorithmic origin compared somebody else's or even one's own prediction and assessment, which suggests, that, at times, humans might be willing to attribute higher levels of trust to the computational power of contemporary machines, even when they are unfamiliar with the machines' inner working mechanisms [28].

Although both empirical aspects outlined above certainly allow for more than one theoretical explanation, this first point of criticism can be summarised as follows: contrary to the implicit notion of anthropomorphism, the breadth and depth of human interactions with machines might be enhanced by the perceived *absence* of humanness (e.g. moral judgement) and the *presence* of non-human machine qualities (e.g. superior computational power).

### B. DVAs' limited scope for anthropomorphic projection

The second point of criticism refers back to an issue raised earlier in the introduction: how much imagination is required when we talk to DVAs? The short answer remains *none*, because, in light of the previous discussion, it would be as odd to argue that, when we interact with DVAs, we behave as if these machines were talking to us, because, strictly speaking, they *are*. But, even if one argues that human-machine interactions, which are restricted to voice-only communication, offer plenty of room for anthropomorphic projection (e.g. [29]), one should keep in mind that DVAs are

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endowed with *real* interactive features and pre-programmed personalities, which may not prevent anthropomorphism per se, but they certainly constitute impeding factors by reducing the potential scope for the imaginative forces of creative control. In fact, exploratory empirical findings reported by [30] show how children systematically probe DVAs in order to understand the inner nature of the machine. Although some of these reported probing behaviours (e.g. asking for DVAs' age or favourite colour, testing DVAs' sense of humour), and children's verbally expressed perceptions about DVAs (e.g. claiming DVAs possess emotions and feelings), seem anthropomorphic at first glance, the entirety of empirical findings by [30] does not suggest that children engage in strong pretend play, or behaving-as-if scenarios. Instead, children systematically attempt to reduce uncertainty by unfolding DVAs' opaqueness. And even if children report firm perceptions about DVAs' inner emotional states, this could be the result of a sincere experience-based judgement that a DVA has effectively communicated an emotional state, rather than expressing a pretended imagination of the DVAs' anthropomorphic inner state of being.

### C. Developmental origins of what it means to be human

Lastly, and most importantly, the argument of anthropomorphism skips a decisive step: claiming that humans are inclined to project their inner idea of human life and mentality onto non-human entities, raises the question where these subjective ideas come from, and the consecutive critical question, how the emergence of somebody's internalised idea of what it means to be human may in itself be affected by interactions with non-human, but nevertheless humanoid entities, such as DVAs. As mentioned earlier (see Section II.A), our inner ideas of human life and mentality gradually mature as part of our development, when we learn – among other things – to recognise others as living kinds with intentions, mentality, intelligence, morality, emotions, or, in short, as humans [10]. However, cognitive development is subject to environmental stimuli, and therefore, changing childhood environments, that are increasingly characterised by humanoid manifestations of AI, could not only change how children think about these technologies, but also about themselves as humans [31]. This reasoning introduces the starting point of NOCH, which is discussed in the next section.

## IV. New Ontological Category Hypothesis

In a nutshell, NOCH argues that children, who grow up in highly technologised environments, might conceptualise humanoid intelligently behaving machines as hybrid beings, between the cognitive domains of living humans, on the one hand, and non-living machines, on the other hand, therefore forming an ontological category in its own right within children's emerging understanding of the world. This section briefly summarises the theoretical substructure of NOCH and exemplifies how it can raise new perspectives around child-machine interactions, in general, and child-DVA interactions, in particular.

### A. Developmental concept of ontologies

In general, human cognitive development describes the iterative process of developing an experience-based understanding of the world by linking the sensual experience of the present with the conceptualised experience of the past [32]. Although these emerging and constantly refined mental representations of reality become more sophisticated, nuanced, and engrained throughout infancy and childhood, their complexity always remains subsumable under a single system of cognitive boundaries, referred to as ontology, which allows for a basic categorisation of entities along the lines of their perceived features and attributes [32][33]. Hence, ontological categories translate into foundational distinctions between the broadest classes of physical existence, such as living and non-living beings, human and non-human living beings, natural and artefactual non-living beings, and so on [17][31][33]. Although research has shown how children may struggle to categorise entities with ambiguous characteristics into ontological categories [35]–[37], the argument of NOCH goes one step further: if certain entities remain 'lost' within a child's ontology, because they display characteristics that relate to multiple ontological natures from the perspective of the child (see Fig. 1), therefore preventing a clear categorisation, a *new* ontological category might be formed in order to overcome cognitive ambiguities [14].

In other words, from the perspective of children, who would have developed a new ontological category for intelligently behaving machines, the question whether Alexa *et al.* are humans or machines might seem as strange as the question whether an orange piece of paper is yellow or red, because, in both cases, the object (i.e. DVA) or quality (i.e. colour) in question would be perceived as something *in its own right* [38].

### B. DVAs: A new ontological category?

Peter H. Kahn and his colleagues, the original authors of NOCH, conceived their idea in light of the technological achievements of the early 2010s [14], but their work predates many of the recent AI breakthroughs, as well as DVAs' tremendous commercial success, and, so far, there have been very few attempts to advance and apply their legacy (for one of the few exceptions see [5]), despite an array of intuitive reasons, why DVAs' humanoid omnipresence could indeed introduce an perceptual ontological change of today's childhood environments. Although an all-encompassing discussion is beyond the scope of this paper, the important point to make here is that, when it comes to the investigation of child-DVA interactions, NOCH urges us to at least consider that this unprecedented context – namely the permanent presence of a humanoid voice in a child's home environment, starting at birth, and lasting into maturity – might also raise unprecedented questions.

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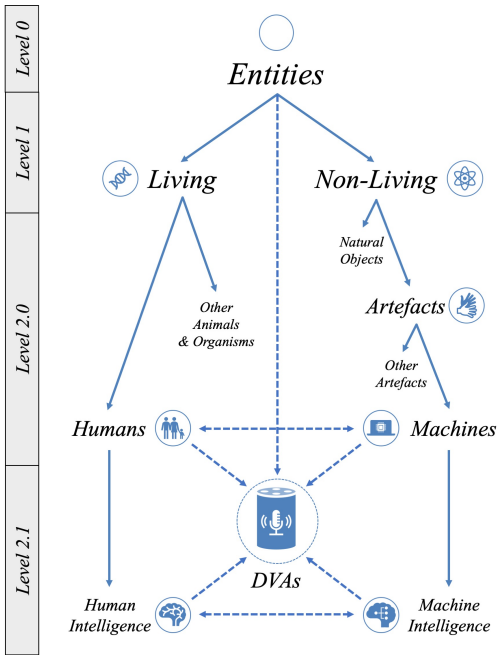


Figure 1. DVAs' embeddedness in children's ontological believe system according to NOCH (Source: compiled by the author, see [40])

In particular, it could explain why children might appreciate DVAs' humanoid (e.g. mastery of human language) as well as non-human qualities (e.g. absence of moral judgement) at the same time (see Section III.A), and why children's interactions with DVAs might not display strong notions of anthropomorphism, such as pretend play or behaving-as-if scenarios. Furthermore, NOCH also urges us to question common assumptions and arguments. For instance, when children use human attributes to characterise DVAs (e.g. she/her, he/his/him), according to NOCH, this would not necessarily imply that children anthropomorphise by projecting humanness onto these machines, because, as a new hybrid ontological category, Alexa *et al.* simply draw upon certain linguistic qualities from one of the ontological 'parent' categories, while remaining a distinct non-human (but nevertheless humanoid) category in their own right.

Another example: the feminist criticism that DVAs' female voices *cause* the reproduction of discriminating stereotypes in children (e.g. [39]), implicitly assumes that children directly associate and equalise the concept of human femininity with artificial femininity, as it is embodied by DVAs' female voices. However, if Alexa *et al.* were hybrid beings in their own right, from an ontological perspective, this assumption would require empirical validation, since it cannot be inferred from theory alone. Or differently spoken, and in line with the metaphor used earlier: if you do not like the colour yellow, can we simply assume that you do not like the colour orange either?

In sum, it may be left to the reader whether NOCH constitutes a paradigm shift that could overcome the implicit shortages of anthropomorphism. But it certainly raises new and potentially important questions in the context of child-DVA interactions, which might be worth investigating.

## V. Conclusion

This paper constitutes a critical review and discussion of the anthropomorphism paradigm, which remains a popular implicit or explicit theme in the literature on human-machine interaction, in general, and child-DVA interactions, in particular. This paper contributes to the literature by raising the argument that NOCH serves as a fruitful theoretical lens for the conceptualisation and empirical investigation of child-DVA interactions, as they take place in children's natural home environments.

## VI. Future Research

The next steps for future research are to develop a research design that allows for the empirical investigation of NOCH in the context of child-DVA interactions.

In particular, the research will focus on the empirical exploration of NOCH with respect to one particular dimension of child-DVA interactions: a comparison of the nature of children's self-disclosure when interacting with DVAs, on the one hand, and humans, on the other hand. This empirical focus seems to be of particular importance, because it sheds light on an important area of tension: as pointed out in the introduction, there is this concrete vision that children might develop close interactive relationships with intelligently behaving machines while growing up with them (e.g. [13][39]). If this notion is combined with the empirical findings reported earlier (see Section III.A), showing how humans are also inclined to appreciate machines' non-human qualities (e.g. absence of human moral judgement), and the theoretical implications of NOCH that children might accept, appreciate, or even prefer a confidant of hybrid ontological nature over a human alternative, this issue seems worthwhile investigating. In addition, given that DVAs, in particular, and, arguably, even AI, in general, will continue to rely on the depth and breadth of insights we are willing to reveal, investigating children's self-disclosure of personal insights would also have important implications for the future role of DVAs in our home environments, which is currently envisioned with a strong emphasis on leveraging user data through the customisation of services [42]. In order to compare the nature of children's self-disclosure when communicating with DVAs, on the one hand, and humans, on the other hand, a mixed methods research design with two major design components is proposed.

### A. First design component

The first design component is supposed to explore the nature of children's self-disclosure by comparing how children share personal insights with a DVA, on the one hand, and with a real human, on the other hand. Although the collection of verbal data through DVAs has already been applied in preliminary research on DVA usage patterns [43]–[47], the future research referred to in this paper attempts to contribute to the literature by using a researcher-designed DVA-application (work-in-progress). For the analysis, the transcribed verbal data are supposed to be explored and compared with computational methods of psychological text analysis [48]–[50]. The focus of the analysis is to explore and

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compare children's self-disclosure patterns both within as well as between the DVA-condition and the human-condition (i.e. between subject comparison and within subject comparison).

### B. Second design component

The second design component is supposed to complement the implicit weaknesses of the quantitative component by providing an in-depth panorama of selected cases, and in order to understand individual reasons and circumstances that might have caused the observed patterns of self-disclosure. Methods of data collection mainly include semi-structured interviews and observations during household visits, which are then used for qualitative means of data analysis in psychology, such as thematic analysis [51].

### C. Additional remarks on future research

The target population of this research consists of normally developing children in industrialised English-speaking countries, who are in the concrete operational stage of their cognitive development (i.e. $\backsim$ 5 to 10 years), and with or without prior domestic DVA exposure at the beginning of the study. The intended sample sizes are $n \rightarrow 50$ for the first component, and $n \rightarrow 10$ for the second component. The beginning of the data collection is scheduled for spring 2021.

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