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How It Evolves over Time

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Children's Acceptance of a Domestic Social Robot: How It Evolves over Time

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Little is known about children's long-term acceptance of social robots; whether different types of users exist; and what reasons children have not to use a robot. Moreover, the literature is inconclusive about how the measurement of children's robot acceptance (i.e., self-report or observational) affects the findings. We relied on both self-report and observational data from a six-wave panel study among 321 children aged eight to nine, who were given a Cozmo robot to play with at home over the course of 8 weeks. Children's robot acceptance decreased over time, with the strongest drop after 2–4 weeks. Children rarely rejected the robot (i.e., they did not stop using it already prior to actual adoption). They rather discontinued its use after initial adoption or alternated between using and not using the robot. The competition of other toys and lacking motivation to play with Cozmo emerged as the strongest reasons for not using the robot. Self-report measures captured patterns of robot acceptance well but seemed suboptimal for precise assessments of robot use.

CCS Concepts: • **Human-centered computing** → *Empirical studies in HCI*; *Field studies*;

Additional Key Words and Phrases: Human-machine interaction, child-robot interaction, social robotics, technology acceptance, technology use

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1 INTRODUCTION

Social robots, which are robots capable of approaching interpersonal interaction [1], increasingly enter more natural environments, such as schools [2, 3] and homes [4–10]. They are also progressively designed for diverse functions, such as entertainment (e.g., [11]), education (for a review, see [12]), and care of children [13]. Therefore, it is timely to study, in the first place, whether children accept social robots at all. Despite the growing interest in **child-robot interaction (CRI)**, and longitudinal perspectives on how children deal with social robots (e.g., [6, 14–17], the majority of

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studies on children's acceptance of social robots is still cross-sectional (for a review, see [18, 19]), which scholars have, more generally, identified as a shortcoming also in the field of **human-robot interaction (HRI)** (see, e.g., [5, 20, 21]).

The prevalence of cross-sectional studies is problematic because social robots, as a relatively novel technology, usually raise high expectations in children and enthusiasm to interact with them, at least initially [22, 23]. However, children's high expectations and enthusiasm are likely to disappear over time, as longitudinal use patterns of robots in educational (e.g., [22, 24]) and domestic settings suggest (e.g., [10]). A sole or predominant focus on initial or single CRIs often leads to the conclusion that, generally, children like and accept social robots whereas this may not be true in a longitudinal perspective (for a review, see [19]). The main aim of this study was therefore to investigate children's acceptance of a social robot through their continued, longitudinal use.

Due to the dominance of cross-sectional studies and the resulting idea that nearly all children like and accept social robots, CRI research has rarely focused on the *non*-use of social robots. However, gaining knowledge on children's non-use of social robots is important because non-use may hinder longitudinal acceptance [25] and, consequently, the intended effects of CRI, such as learning from robots [24, 26]. Moreover, non-use of social robots may become more important as children use robots increasingly in more natural environments, such as in their homes [5], where they may interact more freely with the robot than, for example, in an educational context [6]. Moreover, other factors, such as social (i.e., family) norms and external constraints, may influence the robot's use and acceptance when interacting in a more naturalistic setting [2, 6, 10, 27]. In this study, we thus also focused on whether and why children do *not* use a social robot. Specifically, we wanted to know whether different types of (non-)users can be distinguished when we explicitly consider that, over time, children may stop using a robot. Additionally, we centered on potential reasons for not using a robot because they can be informative in identifying factors that hinder acceptance [25]. To date, these aspects have not received much systematic research attention or are mainly studied in small populations, limiting the generalizability of existing results.

The literature on children's acceptance of social robots is somewhat inconclusive about the extent to which the measurement of acceptance affects the findings [18, 19]. Specifically, it is unclear whether self-report measures of robot acceptance, which are usually rather easy to implement, are suitable for measuring children's acceptance of social robots and may be an alternative to observational measures. Without such knowledge, however, future researchers may either opt for suboptimal measures or engage in unnecessarily demanding types of data collection. In the present study, knowledge about the performance of self-report and observational measures may improve the trust in, and validity of, the findings.

In this study, we target children in middle childhood (i.e., aged eight to nine). Compared to younger children, children in middle childhood are capable of participating in surveys [28, 29], while also mastering several social and relational skills related to CRI [30]. These varying, and developing, psychological skills may result in different longitudinal trajectories across children in middle childhood and are thus, in the light of longitudinal acceptance, important to study.

1.1 Children's Longitudinal Acceptance of Social Robots

Acceptance is defined in the literature as a process in which a technology is eventually integrated into a person's (daily) life [31] and can be observed through the person's longitudinal and repeated use (i.e., behavioral acceptance) and their intention to do so (i.e., intentional acceptance), which distinguishes it from mere interest in, or adoption (i.e., the initial implementation [32]) of, a technology [19, 31–36]. Conversely, rejection or discontinuance (i.e., abandonment after initial adoption [25]) can be observed through (longitudinal, repeated) non-use of a technology.

Some longitudinal CRI research has suggested that children's acceptance of the robot remains stable over time. However, these studies either included a limited number of interactions (i.e., three

sessions) [37, 38], a small sample [37, 38], or focused on very young children (i.e., toddlers) [39, 40]. Other longitudinal studies on CRI, in contrast, have suggested that children's acceptance of a social robot decreases over time and that some children completely stop using the robot [22, 41–43]. All these studies focused on social robots for education or therapy, which may differ from domestic settings in the degree to which children experience the freedom to interact with the robot or not [6]. Still, longitudinal studies with domestic social robots have elicited similar findings [6, 10, 44]. However, the results of previous longitudinal studies on children's acceptance of social robots may have been affected focusing on the family as a whole rather than on the child and/or by considering specific roles of a social robot (e.g., reading companion; e.g., [45]). Moreover, samples were generally rather small. Against this background, we aimed in a first step to validate prior evidence on diminishing use in a larger sample focusing on dyadic CRIs in a domestic setting with a sociable robot. Based on previous evidence, we hypothesized:

H1: Children's acceptance of domestic social robots will decrease over time.

1.2 Different Types of (Non-)Users of Social Robots

Existing empirical CRI research suggests that there are different groups of children in terms of their acceptance of social robots. For example, Kanda et al. [22] found in their longitudinal study that even though the largest group of children lost interest in the robot by the second week, a small group of children kept interacting with the robot during that second week. Moreover, the variation between children in interaction time with the robot was particularly high. A similar picture emerged in another study by Kanda et al. [41], who distinguished between a group of children who played with the robot for more than half of the days and a group of children who played for less than half of the days. They found that the first group, compared to the second group, showed a higher average interaction time per day over the course of 8 weeks. The first group also continued playing with the robot over the 2 months, whereas the second group only used the robot in the first stages and before its leave.

Kanda et al.'s [41] findings largely correspond with empirical research on adults' interaction with domestic social robots, which has shown that people may exhibit different use patterns over time (e.g., [32, 46]). For example, a longitudinal study on adults' acceptance of a domestic social robot [32] found that most participants did not use or only rarely used the robot at the end of the study (i.e., after 6 months). A small group, however, kept on using the robot in a stable fashion over the course of the study [32]. This idea of different types of robot users is also suggested by studies on domestic social robots with families who "owned" a robot for an extended period (i.e., 4 weeks [10] and 2 months up to 10 months [44]). Zhao and McEwen [10], for example, found that, whereas the overall number of active users decreased, 6 families used the robot daily, 1 stopped using it fully, and 13 families used the robot once or twice a week. However, these families bought the robot themselves and were thus already interested in the robot, which may have positively affected its acceptance [10]. Similarly, Fernaeus et al. [44] found that most children in their study initially interacted with the robot but stopped using it afterwards and used it only rarely on special occasions. A small number of children did not play with it at all. There is thus reason to assume that, overall, children's robot acceptance may decrease, but with different trajectories across children. Some children may fully accept the robot over time, while others—probably the majority—may stop using it after some time. This calls for more attention to the non-use of social robots [25, 47, 48].

A useful theoretical framework for studying children's non-use of domestic social robots is the diffusion-of-innovation framework by Rogers [36]. The acceptance (or diffusion-of-innovation) process starts with the innovation phase, which takes place "when an individual engages in activities that lead to a choice to adopt or reject the innovation" [36, p. 172]. At the decision stage, most people will try out the innovation on "a probationary basis" [36, p. 172] including "small

scale trials" [36, p. 172]. Individuals who pass this decision stage but then decide not to adopt the innovation are termed *(active) rejecters*[1] [36]. Several studies have shown that children initially interacted with the robot but stopped interacting with it after a short time (i.e., after initial trials). Following Rogers [36] and others [25, 47], we call this group *rejecters*. For example, two studies that were conducted with social robots at elementary schools over the course of 2 weeks showed that most children frequently interacted with the social robot during the first week,[2] but the majority stopped interacting with the robot during the second week [22, 42]. Another study found that children already rejected a robot after three interaction sessions [43]. Finally, a study on adult robot users in the domestic context showed that one-fifth of the participants rejected the robot [25].

Discontinuance [25, 36] refers to "a decision to reject an innovation after having previously adopted it" [36, p.186]. Some studies have provided evidence for the existence of such a group of *discontinuers*. One study found that children increasingly refused to interact with a social robot over the course of 11 weeks (with one session per week) [49] and another study concluded that most children stopped using the social robot after 5–7 weeks of use [41]. Finally, a study on adult robot users also showed that, of all non-users, the group of discontinuers, who stopped using the robot after 2–6 months, was the largest. After 6 months, slightly more than half of the participants had stopped using the robot [25]. Based on Roger's [36] categorization and empirical research in CRI and HRI, it is thus plausible to assume that there are different categories of non-users, based upon whether they decided to reject the robot prior to actual adoption (i.e., *rejecters*) or adopted the robot but later decided to stop using it (i.e., *discontinuers*).

Research on CRI has also suggested that children may not only just reject, or discontinue using a robot, but may show a hybrid acceptance of social robots [44]. Hybrid acceptance means that users may alternate between using and not using the robot. The idea of hybrid robot acceptance corresponds with research on children's play practices in general (e.g., [50]), which has shown that "children often move in and out of, and between different activities, and how toys are commonly transferred [...] between different contexts" [44, p. 41]. For example, in the longitudinal field study by Kanda et al. [41], even those children that showed less interest in the robot over time, resumed use of the robot upon envisioning its leave. In our study, we will call these children *resumers*.

Overall, we thus studied how children are distributed across these theory-based predefined categories of use of social robots. Specifically, we asked:

RQ1: In terms of children's acceptance of domestic social robots, how many children can be classified as users, rejecters, discontinuers, and resumers?

1.3 Children's Reasons for Non-use

As research to date has rarely dealt with children's non-use of social robots, little is known about the reasons for why they may decide not to accept it. Insight into children's reasons for non-use can be informative in identifying factors that obstruct children's acceptance of social robots [6, 25, 45]. For adults, de Graaf et al. [25] identified seven reasons for non-use: disenchantment, end of novelty, lack of motivation, needs not satisfied, necessity to rely on others to use the robot, replacement by other device, and restrictions and problems. For rejecters (i.e., defined by de Graaf et al. [25] as those who stopped at 2 weeks or 1 month after introduction), disenchantment as well as restrictions and problems were the main reasons, whereas discontinuers (i.e., defined by de

[1]In this study, we are unable to distinguish between not wanting to participate in the study or refusing to interact with the robot. Therefore, we will not include *passive rejecters* [36] (i.e., those never considering use) or *resisters* [25], [47] (i.e., those who refuse to interact with the robot prior to initial introduction) in our analysis.

[2]Given the limited interaction time per child (i.e., interactions in groups of children, only freely during the break) we consider this initial trials.

Graaf et al. [25] as those who stopped at 2 or 6 months after introduction) most often mentioned that the robot was unable to satisfy their needs; that they replaced the robot by another device; and that they experienced restrictions or problems [25]. Reasons for non-use thus seemed to vary not only generally, but also depending on the point of time when users stopped.

Several studies in CRI have focused on factors causing disrupted interactions, both cross-sectionally [2] and longitudinally [17], and factors influencing long-term engagement with the robot [6]. They showed that several robot and interaction factors (e.g., a violation of social norms or a lack of consistency in the interaction [2, 17]) may impact children's acceptance. However, also external factors (e.g., a vacation) and the children's personal interest (e.g., in the robot's interaction flow) may affect the longevity of the interaction [6].

To our knowledge, only one study has explored children's reasons or beliefs for rejection (i.e., at pre-adoption) of a social robot [27]. Focusing on a domestic social robot, the authors found that when children intended to reject the social robot, they often referred to normative beliefs (i.e., what others think of the behavior, such as "My mother would not like it") and control beliefs (i.e., beliefs about knowledge and source factors, such as "It's not possible with my dog") [27], which overlaps with the "restrictions and problems" category by [25]. Beliefs at pre-adoption, prior to or after limited real-life exposure, are mainly shaped by expectations and indirect experiences, whereas after adoption they are mainly shaped by actual experiences (e.g., [25, 32, 51–53]). Consequently, we do not know whether the reasons for intended rejection (i.e., prior to adoption) also hold for discontinuation (i.e., after adoption) and/or for a hybrid form of acceptance.

Two additional reasons for non-use of social robots often mentioned in the CRI literature are the expectation-performance gap (e.g., [44, 54]) and the novelty effect (e.g., [24, 54]). The expectation-performance gap refers to a mismatch between expectations of and actual experience with the robot [54] and is similar to de Graaf et al.'s [25] "disenchantment" and "need not satisfied" categories. The novelty effect is an innate tendency to focus on novel stimuli, while becoming less responsive to stimuli after a certain amount of exposure [54, 55] and resembles what de Graaf et al. [25] call "end of novelty." Based on existing literature and de Graaf et al.'s [25] categorization of reasons for non-use, various reasons for children's non-use of social robots seem plausible, which may change over time. We therefore asked:

RQ2: What are children's reasons for non-use of a social robot, and do they differ over time?

1.4 Self-report versus Observational Measures of Longitudinal Acceptance

The longitudinal studies on children's robot acceptance mentioned above have typically used observational measures. However, self-report measures of children's robot acceptance are still widely used, especially in cross-sectional studies [18, 19], probably because they are usually easy to implement and require less temporal, financial, and technological resources. At the same time, self-report measures have been criticized for several shortcomings (e.g., social-desirability bias; see [56, 57]), and could explain the absence of variance in children's robot acceptance [19]. Moreover, a recent meta-analysis has shown that self-report and observational (i.e., logged) measures of media use correlated only moderately [58]. The meta-analysis deals with media use more generally (social media, phone, internet, computer) and may not be fully applicable to children's acceptance of social robots. Still, it raises the question about the extent to which self-report measures of robot use may also be useful for studying children's acceptance of social robots.

As the data used for this study assessed self-report and observational measures of children's robot acceptance (i.e., operationalized through use), we were able to compare self-report measures with observational measures. This is relevant for the current study for two reasons. First, if children's acceptance of social robots follows the same pattern over time both in self-report and observational measures, researchers may find in self-report measures a useful and cheaper alternative

to observational measures, at least as far as the detection of patterns in children's robot acceptance is concerned. Second, as little is known about whether the identification of different types of (non-)users would be influenced by relying on self-report or observational data, we are also able to obtain—in an exploratory fashion—first insights into the extent to which the identified groups differ between the two means of data collection. Previous research focused on measures of the use of media rather than of social robots [58]. We, therefore, abstained from a hypothesis and asked:

RQ3: (a) To what extent does the pattern of children's longitudinal acceptance of robots differ between self-report and observational measures? (b) Are children classified congruently across the categories of (non-)user types when relying on self-report vs. observational data?

2 METHOD

For this study, we used data from a larger study on children's acceptance of a domestic social robot at home, which ran from July to December 2019. Our full study was an online panel study with six waves of data collection, consisting of a baseline measurement (i.e., T0)—which ran from August 21 to September 8, 2019—and a follow-up study (i.e., T1–T5), which ran from September 24 and December 25, 2019. In this study, we focus on the follow-up study and only include data from T1 to T5. Data from the baseline measurement (T0), which are not part of the present study, have been used in [59]. The full study was approved by the Ethics Review Board of the Faculty of Social and Behavioural Sciences at the University of Amsterdam (UvA) (Id: 2019-YME-10929). Kantar Netherlands recruited participants and collected the data for this study.

2.1 Procedure

Prior to the start of data collection—from July 18 to August 11, 2019—parents of all families that were eligible for participation (see below) were invited to fill in an online screening questionnaire in which they were elaborately informed about the study's procedure, data storage, and analysis, and both their and their children's rights as participants. We also informed them that we would randomly select a sub-group of participants for the follow-up study (i.e., T1–T5), in which the selected families would receive a small social robot as well as a tablet for their child. However, we instructed them not to tell their children about the robot before completing the first questionnaire (i.e., T0). Moreover, we informed them that, in the follow-up study (i.e., T1–T5), we would also, on the enclosed tablet, collect user-data (i.e., logfiles) from the robot, such as frequency of use and choice of robot functions, which would only be used by the researchers and for research purposes. If they agreed to participate, they were asked to give active consent for the full study (i.e., including the follow-up study) for themselves and their child. Two reminders were sent on August 1 and 6, 2019.

For all waves, the questionnaire consisted of a part for one of the child's parents (which is not used in the present study) and a part for the child. At the start of each questionnaire, parents were reminded, among other things, of the voluntary character of their participation and their rights as participants. Parents were instructed to fill in the questionnaire on their own and to let their child fill in their questionnaire individually. They could help their child but were asked to remain neutral and not to influence their child's answering.

At the start of each questionnaire, children were told, in child-appropriate language, that there were no right or wrong answers. Additionally, they were told that they could terminate the study at any time and that, via their parents, they could also request removal of data. Children were also reminded that they could take a break while filling in the questionnaire. We also explained that we would publish about the findings of the study, but that their anonymity was safeguarded in such publications. Children had to confirm that they understood everything and wanted to start the questionnaire. The 5-point Likert response scale, which was used for most questions, was explained to the children at the beginning of the first questionnaire (see [59]).

2.1.1 Data Collection. Prior to the start of the data collection, families received an e-mail with an invitation and elaborate information on the study and the social robot. We instructed them to let their child start playing with the robot at the first day of the follow-up study and that only the child that participated should play with the robot. Finally, we informed them about how their privacy was safeguarded, specifically that the child would not be filmed and that no videos or photos were saved at the robot or tablet. Moreover, we instructed them to use a fictional birthdate when setting up the robot and to not connect the tablet (which we enclosed with each robot) to another Wi-Fi network other than the one we had preconnected it to (i.e., the Wi-Fi network of the robot) because then the logfile data would no longer be available to us. We protected the settings with a password, known to parents, to prevent children from connecting to another Wi-Fi network themselves. Before the data collection started, we had received written permission by Anki to use the logfiles provided that we asked for the users' consent and disclosed in our publications that Anki was not involved in the study in any way. (When the study was conducted, Anki was the company producing Cozmo. Today this is Digital Dream Labs).

For each wave, parents filled in their part of the questionnaire (about 5 minutes) first, after which the children filled in their part (about 30 minutes). The questionnaires were largely identical across the five waves and focused on children's use of, opinions about, or beliefs of (using) the Cozmo robot. At T1, children were first introduced to the social robot Cozmo. As the instructions and Cozmo's app are in English, families received an elaborate manual in Dutch for setting up and using the robot [25, 41]. Moreover, Kantar Netherlands provided a helpdesk on working days (from 09.00 to 18.00) and answered any questions through e-mail within 24 hours.

Children were instructed to play with Cozmo for half an hour and to subsequently fill in the T1 questionnaire. Therefore, no data of robot use, as relevant for this study (see below), were collected at T1. After this questionnaire, they could play with the robot whenever they wanted. Children were asked to fill in all questionnaires, even if they no longer played with the robot. After T1, children filled in four more questionnaires (i.e., T2–T5), each fielded after an interval of about 2 weeks. For T1 and T2, families had 3 days to fill in the questionnaire, which, from T3 onwards, was extended to 6 days to reduce attrition. At T4, families could fill in the questionnaire also on the seventh day, on which they also got an additional e-mail reminder. In each wave, up to three e-mail reminders and a text message were sent.

At the end of the study, parents and children received a written debriefing in which they were informed about the purpose of the study. Children were additionally informed about the mechanical nature of the robot and some of the differences between humans and robots (see [60]). As previous research showed that taking away a social robot could lead to a sudden increase in use (see [41]) and could affect children emotionally as they may have gotten attached to it [1, 41, 61], children were allowed to keep the social robot as a gift after filling in the last questionnaire (T5) (for a similar procedure, see [25]). Parents were asked to return the tablet and received a small compensation for their participation in the form of points, which they could exchange for money.

2.2 Sample

Kantar Netherlands recruited participants through their existing panel of 62,825 Dutch families in which 1,574 families fit the requirements for participation (i.e., one child aged 8 or 9 during data collection; families with more than one child aged 8 or 9 were not eligible; see Figure 1 for a flowchart of the sampling procedure). The existing sample has been recruited largely through traditional sampling methods (e.g., by letter, face-to-face, and by phone), using the Dutch Personal Records Database (i.e., "Basisregistratie Personen" (BRP)), thus precluding self-selection. It closely resembles the Dutch population in terms of sex, age groups, geographical distribution, and household size. Families were eligible for participation if their child had no cognitive, emotional, and/or

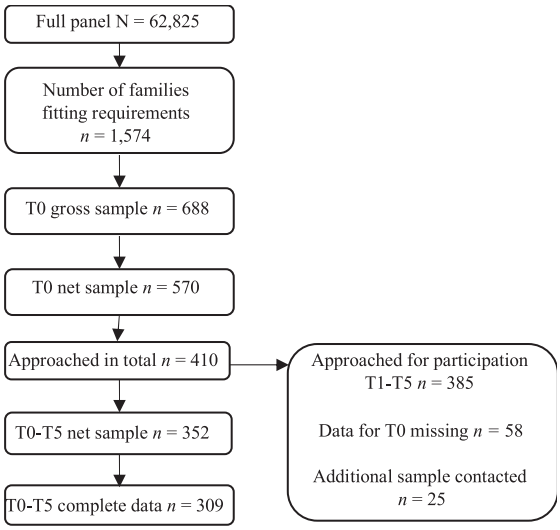

Fig. 1. Flowchart of the sampling procedure.

physical impairments that would hinder filling in the questionnaire or interacting longitudinally with a (small) social robot and tablet—and if they did not have a Cozmo robot at home already. A total number of 688 families (43.7%) consented to participate (i.e., T0 gross sample), of which 570 children and parents (i.e., child-parent dyads; 82.8%) filled in the baseline measurement (i.e., T0 net sample).

From those who had consented to participate in the entire study, 385 child-parent dyads were randomly selected and successfully contacted to participate in waves T1–T5, given an expected attrition of 20% across all waves and taking into account financial and organizational resources. Of 58 of these dyads, T0 data were missing as they had consented but did not participate in T0 (i.e., they were part of the T0 gross sample). To yet approach the initial target of complete self-report data across all waves, an additional sample of 25 child-parent dyads was contacted from the T0 net sample 5 weeks after the initial sample for waves T1–T5 had been recruited. The intervals between sending out the invitations for each wave were the same in the two groups, except for T5 when the invitation for the additional sample was sent out 1 day earlier because of Christmas Eve. Overall, a total number of 352 dyads was thus successfully contacted from the T0 net sample of whom 309 filled in all waves (i.e., T0–T5).

In the current study, we only deal with child data. Moreover, data from the baseline measurement (T0) are not relevant because robot use could only be meaningfully assessed after receiving the robot. This enabled us to also include children for whom T0 data were missing. Four hundred children of the 410 child-parent dyads that overall were approached for participation in waves T1–T5, had filled in at least one of these waves. Although self-reported robot use, as relevant to this study, could not be assessed at T1, the date of filling in T1 was required to calculate observed robot use at T2 (see below). For our final sample in this study, we thus excluded children with missing self-report data across T1–T5 (n = 46) as well as children with incomplete or missing logfile data (n = 41). For T1, 346 children had complete self-report and logfile data. The final sample of the present study consisted of 321 children with complete self-report and logfile data across waves T1–T5 (female, 49.8%; 8-year-olds, 49.8%; attrition rate, T1–T5 = 7.2%; some children lacked both self-report and logfile data).

2.3 The Cozmo Robot

We employed the Cozmo robot (formerly Anki, currently Digital Dream Labs), which is a small caricatured robot [62], inspired by Wall-E and Eve (Pixar) [63]. It is controlled by an app on a smartphone or tablet and communicates through sounds, movements, and its screen [63]. It "learns, adapts and responds to users" [64, p. 11] and thus qualifies as a sociable robot (i.e., a robot that "model[s] people in social and cognitive terms in order to interact with them" [65, p. 169], which is the highest level of sociability in social robots [64]). The sociable nature of Cozmo and its dynamic embodiment (i.e., physically present in the real world) qualifies Cozmo as a social robot [64]. This differentiates Cozmo from smart or connected toys, especially when it comes to the degree to which is employs, for example, interactivity [66].

We chose Cozmo for four reasons. First, given its cartoon-like appearance, we expected it to evoke little negative feelings or discomfort [67, 68] and more realistic expectations about a social robot than a human-like robot [54]. Second, Cozmo does not need to be programmed by the researcher or user and can function autonomously (for a similar argumentation, see [4]), which was essential given the size of the sample and duration of the study. Third, the robot is relatively affordable, which contributes to the ecological validity of the study (for a similar argumentation, see [4]). Fourth and finally, the robot is stable and solid enough to be used without supervision of the researcher or parent. Prior to the study, we observed among several children that they were more enthusiastic about, and interested in, Cozmo compared to Pleo (Innvo Labs).

2.4 Measures

In the current study, we focus on children's acceptance of the social robot, which, in line with the definition, we operationalize as longitudinal use.

2.4.1 Self-Reported Social Robot Use. From T2 to T5, children were asked to report on how many days they had played with Cozmo (i.e., *frequency*) since they had filled in the previous questionnaire. Answering categories included: "On none of the days" (1), "On some days" (2), "On half of the days" (3), "On most days" (4), and "On all days" (5).

To compare self-reported use with observed use, the scale for self-reported use was, in line with the observational data (see below), recoded to range from zero to one (i.e., "On none of the days" [0], "On some days" [0.25], "On half of the days" [0.5], "On most days" [0.75], and "On all days" [1]).

2.4.2 Observed Social Robot Use (Logfiles). Log data were retrieved from an automatically generated logfile (i.e., DAS log folder) from the app of the Cozmo robot. The logfiles contained information on all "actions" performed by or with the robot such as duration of play and functions used. Moreover, they contained timestamps signaling the time at which the robot was turned on and off. Based on those timestamps and by means of a Python script, we generated a file for each participant, which included how long Cozmo was used each day.

We prepared the data on observed robot use to be in line with the self-report data. Logfile data included for each child the duration of use of the robot per day. In R (version 4.0.3), these data were added to the survey dataset, which also included the interview dates. Based on the interview dates (i.e., from the day after filling in the previous questionnaire up to and including the day of filling in the respective questionnaire) and the logfile measure of use, we calculated for each child and per wave two scores: The length of the interval between two waves (in days) and the number of days on which the child had used the robot in a given interval. Finally, the number of days of use was divided by the interval length to arrive at "proportion of days of use." The resulting dataset was then added to the (self-report) questionnaire data in SPSS (version 25), which was used to analyze the data.

Table 1. Descriptive Statistics and Paired *t*-Tests for Self-reported and Observed Use

	Self-reported Use			Self-reported Use Rescaled		Observed Use		*t*(320)	*p*	Cohen's *d*
Wave	*n*	*M*	*SD*	*M*	*SD*	*M*	*SD*			
T2	321	2.86	0.98	0.47	0.25	0.31	0.19	−13.62	<0.001	0.70
T3	321	2.19	0.90	0.30	0.22	0.12	0.14	−17.21	<0.001	0.94
T4	321	1.92	0.89	0.23	0.22	0.08	0.11	−14.05	<0.001	0.87
T5	321	1.80	0.80	0.20	0.20	0.07	0.09	−14.22	<0.001	0.88

Note: For the paired *t*-tests reported in Section 3.4, we made use of the rescaled variable of self-reported use (see Measures).

2.4.3 Types of (Non-)Users. Children were categorized into different types of (non-)users based on their self-reported and observed use of the social robot, and for both types of measurement separately. In line with Rogers [36], children were categorized as rejecters if there was non-use at T2 (i.e., they stopped using the robot in the period from T1 to T2, but had at least one trial at T1; see Section 1.2); as discontinuers if there was non-use at T3, T4, or T5 (i.e., they stopped using the robot in the period after T2); as resumers if there was non-use at any of the time points (i.e., at T2–T4) and if they resumed use in a later wave (i.e., at T3–T5, to possibly show non-use again after having resumed use); and as users if there was use in every wave.

To analyze whether the identification of (non-)user types was congruent when relying on self-report or observational data, we recoded the data to include, per user group, a dichotomous variable for the self-report and observed data to represent whether a child belonged to that (non-)user group.

2.4.4 Reasons for Non-Use. From T2 to T5, children who indicated that they had not used the robot (i.e., answering "On none of the days" for *self-reported robot use*) were additionally asked to answer the question about reasons for non-use. The measure consisted of seven items with children answering on a five-point Likert scale ranging from "Does not apply at all" (1) to "Applies completely" (5). The items were based upon seven categories for non-use [25] and were translated into child-appropriate language, resulting in the following measure: "And why did you not play with Cozmo? I did not play with Cozmo because…, (1) I am disappointed by what Cozmo can do (i.e., *disenchantment*), (2) I do not find Cozmo interesting (i.e., *loss of interest;* end of novelty in [25]), (3) I do not feel like using Cozmo (i.e., *lack of motivation*), (4) Cozmo cannot do the things I would like it to do (i.e., *need not satisfied*), (5) I cannot use Cozmo without someone helping me (i.e., *reliance on others*), (6) I rather play with other things instead of Cozmo (i.e., *replaced by another device/thing*), (7) there are problems with Cozmo preventing me from playing with it" (i.e., *restrictions/problems*).

2.4.5 Sex and Age. Data on children's sex were provided by Kantar Netherlands. The measure included two categories: boy (1) and girl (2). Kantar Netherlands also provided us with children's age (either 8 or 9) based on children's date of birth (reference date 19-08-2019; see sample for the descriptive statistics).

3 RESULTS

3.1 Longitudinal Acceptance

H1 predicted that children's acceptance of the social robot would decrease over time. A repeated-measures ANOVA showed that children's self-reported use of the domestic social robot decreased over time: $F(2.72, 868.85) = 157.12$, $p = <0.001$, $\eta_p^2 = 0.33$ (see Table 1 for descriptive statistics). As Mauchly's Test of Sphericity was significant ($\chi^2(5) = 52.85$, $p < 0.001$), and the Greenhouse-Geisser estimate above 0.75, degrees of freedom were corrected using Huynh-Feldt estimates of sphericity. Repeated contrasts revealed that, in each interval, children's self-reported use in a given

Table 2. Type of (Non-)User based on Self-reported Use and Observed Use

Type	Self-reported Use		Observed Use	
	n	%	*n*	%
User	150	46.7	90	28.0
Rejecter	2	0.6	6	1.9
Discontinuer	107	33.3	122	38
At T3	*25*	*7.8*	*34*	*10.6*
At T4	*39*	*12.1*	*47*	*14.6*
At T5	*43*	*13.4*	*41*	*12.8*
Resumer	62	19.3	103	32.1
At T2	*6*	*1.9*	*7*	*2.2*
At T3	*28*	*8.7*	*53*	*16.5*
At T4	*28*	*8.7*	*43*	*13.4*
Total	321	100	321	100

wave differed significantly from self-reported use in the consecutive wave: self-reported use was significantly higher at T2 compared to T3 ($F(1, 320) = 157.85$, $p = <0.001$, $\eta_p^2 = 0.33$), which was significantly higher compared to T4 ($F(1, 320) = 32.05$, $p = <0.001$, $\eta_p^2 = 0.091$), which in turn was significantly higher than self-reported use at T5 ($F(1, 320) = 6.15$, $p = 0.014$, $\eta_p^2 = 0.02$).

A second repeated-measures ANOVA indicated that children's observed use of the robot also decreased over time: $F(2.36, 753.97) = 389.98$, $p < 0.001$, $\eta_p^2 = 0.55$ (see Table 1 for descriptive statistics). Mauchly's Test of Sphericity was significant ($\chi^2(5) = 125.19$, $p < 0.001$) and the Greenhouse-Geisser estimate above 0.75, and thus degrees of freedom were, again, corrected using Huynh-Feldt estimates of sphericity repeated contrasts showed that T2 and T3 ($F(1, 320) = 480.86$, $p < 0.001$, $\eta_p^2 = 0.60$) and T3 and T4 ($F(1, 320) = 46.30$, $p < 0.001$, $\eta_p^2 = 0.13$) differed significantly from one another, whereas T4 and T5 did not ($F(1, 320) = 3.13$, $p = 0.078$, $\eta_p^2 = 0.01$). Overall, the findings support H1, showing that, generally, children's acceptance of the domestic social robot decreased over time.

3.2 Types of (Non-)Users

The first research question asked how many children could be classified as users, rejecters, discontinuers, and resumers. Most children ($n = 150$; 46.7%) reported that they had used the social robot across all four waves (see Table 2). Moreover, a large group of children ($n = 107$; 33.3%) reported having discontinued the use of the robot, of which most did so at T5 (see Table 2). There was also a smaller group of resumers ($n = 62$; 19.3%) who stopped using the robot, but later resumed use. Most of these children reported non-use at T3 or T4, and only very few at T2. Only two children (0.6%) reported having rejected the robot (i.e., reported non-use from T2 on).

As to observed use of the social robot, most children could be classified as discontinuers ($n = 122$; 38%), of which most stopped using the robot at T4 (see Table 2 for details). Moreover, based on the observational data a large group of children could be classified as resumers ($n = 103$; 32.1%) of whom most showed non-use at T3 ($n = 53$) or T4 ($n = 43$). A smaller group of children ($n = 90$; 28.0%) could be classified as users based on the observational data. Finally, only six children (1.9%) could be classified as rejecters based on the observational data.

3.3 Reasons for Non-use

The second research question asked what children's reasons for non-use of a social robot were, and whether they differed over time and per (non-)user type. The descriptive statistics showed that the

Table 3. Descriptive Statistics and Test Statistics for Reasons for Non-use Over Time

		Problem		Reliance		Disenchantment		Need		Interest		Motivation		Replaced				
Wave	*n*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	*p*	η_p^2
T2	8	1.38	0.74	1.75	1.17	2.13	0.84	1.88	0.99	2.25	1.04	2.50	1.60	2.88	1.25	1.93	0.098	0.22
T3	57	1.33^{a}	0.66	1.68^{ab}	1.00	1.96^{b}	0.98	1.95^{b}	0.90	2.47^{c}	1.20	3.02^{d}	1.25	3.42^{e}	1.28	43.52	<0.001	0.44
T4	110	1.55^{a}	0.88	1.67^{a}	0.92	2.15^{b}	1.00	2.21^{bc}	1.10	2.55^{c}	1.12	3.22^{d}	1.21	3.67^{e}	1.14	78.80	<0.001	0.42
T5	117	1.59^{a}	0.82	1.66^{a}	0.90	2.24^{b}	0.95	2.44^{bc}	1.07	2.72^{c}	1.27	3.26^{d}	1.22	3.75^{e}	1.11	88.36	<.001	.43

Note: Means for T3-T5 not sharing a superscript (e.g., 1.33a 1.96b) significantly differ at $p < 0.05$. As Mauchly's Test of Sphericity was significant (T3: $\chi^2(20) = 84.68$, $p < 0.001$; T4: $\chi^2(20) = 106.59$, $p < 0.001$; T5: $\chi^2(20) = 140.72$, $p < 0.001$), the degrees of freedom were corrected using Huynh-Feldt estimates of sphericity.

reasons for non-use followed a similar pattern over time: Across all waves, children most strongly agreed with "I rather play with other things" (i.e., robot was replaced by another device/thing), followed by a lack of motivation and loss of interest. Across all waves, children seemed to agree least with restrictions/problems and reliance on others (see Table 3).

We tested with a repeated-measures ANOVA with Bonferroni post-hoc comparisons (see superscripts in Table 3) whether agreement with reasons of non-use also significantly differed within a wave. At T2, the reasons for non-use did not differ significantly (see Table 3 for test statistics). Children agreed with all reasons equally. For T3, T4, and T5, in contrast, all reasons for non-use differed significantly from one another, with the following exceptions: First, in all three waves the reasons of disenchantment and "needs not satisfied" (for all waves: $p = 1.00$) as well as reliance on others and restrictions/problems emerged equally (T3: $p = 0.206$; T4: $p = 1.00$; T5: $p = 1.00$). Second, at T3 "needs not satisfied" and reliance on others ($p = 1.00$) as well as disenchantment and reliance on others did not differ significantly ($p = 1.00$). Third, for T4 and T5 loss of interest and "needs not satisfied" yielded equal agreement ($p = 1.00$; $p = 0.755$, respectively). Nevertheless, the pattern of agreement was comparable across waves (see Table 3).

The *n*'s in the four waves consisted at least partly of different participants, and focusing, across the waves, on the same participants would have led to low numbers. As a result, we could not statistically test whether agreement with each reason significantly changed over time [69]. However, an inspection of the descriptive statistics suggests that agreement with these reasons for non-acceptance generally seemed to increase or remain relatively stable over time.

An additional post-hoc analysis (not shown) revealed that, within each wave, the pattern of agreement with the reasons for non-use (see Table 3) applied largely to both discontinuers and resumers. As the number of rejecters across all waves ($n = 2$) and the number of resumers at T2 ($n = 6$) and T5 ($n = 8$) was very small, post-hoc tests could not be reliably interpreted.

3.4 Self-reported Versus Observed Use

In response to RQ3a, we found that the pattern of decreasing use emerged for both measures of acceptance, with the exception that the observational data did not show a significant decrease between T4 and T5, whereas the self-report data did (see Section 3.1). Paired *t*-tests between children's self-reported use (rescaled; see Method) and observed use of the robot showed that for all waves self-reported use was significantly higher than observed use (see Table 1 for descriptive and test statistics). The effect sizes are moderate for T2 and large for T3–T5. In general, there was thus a discrepancy between the observational and self-report data: Participants over-reported their own robot use.

RQ3b asked whether the classification of children across (non-)user types was congruent when relying on self-report and observational data. We ran, per (non-)user type, a McNemar mid-*p* test

to analyze whether the classification of children to a specific (non-)user type significantly differed between the self-report and observational measure (see Method for rescaling procedure). The McNemar test is a frequently used test for binary matched or, as in our case, within-person data. We opted for the mid-p test as it performs significantly better than the exact conditional and asymptotic test with continuity correction, and almost as well as the—computationally complex—exact unconditional test, which is only available in specific software (i.e., StatExact) [70].

The results showed a significant ($p < 0.001$) discrepancy in the classification of *users*. For those who were classified as *user* based on self-report ($n = 150$), 76 were also classified as user based on the observational data, whereas one was classified as *rejecter*, 31 as *discontinuers*, and 42 as *resumers*. For the category of *rejecters* there was no significant discrepancy ($p = 0.289$), which may have been caused by the low number of rejecters in the sample. Of the self-reported *rejecters* ($n = 2$), one was classified as discontinuer, whereas the other was classified as resumer based on the observational data. For the category of *discontinuers*, there was also no significant discrepancy ($p = 0.101$) in the classification. Of the self-reported *discontinuers* ($n = 107$), 78 were also classified as *discontinuers* based on the observational data, whereas 9 were classified as users, 4 as rejecters, and 21 as resumers. Finally, for the category of *resumers*, there was a significant discrepancy ($p < 0.001$). For the self-reported *resumers* ($n = 62$), 40 were congruently classified as *resumers* whereas 8 were classified as users, 2 as rejecters, and 12 as discontinuers based on the observational data. Thus, when relying on the self-report data, a large part of the children were classified as users (see Table 2), whereas based on the observational data almost half of them were classified differently (either as discontinuer or resumer). However, the moment at which, according to the observational data, the resumers stopped using the robot seemed to correspond to the self-report data: Only very few children stopped using the robot at T2 to later resume use ($n = 6$, 1.9%; $n = 7$, 2.2%, respectively).

4 DISCUSSION

In the current study, we aimed to gain more initial insight into children's longitudinal (observed and self-reported) acceptance of a social robot at home and into different groups of (non-)users as well as reasons for non-use over time. The results may also extend to smart and connected toys because these toys and social robots have several features in common [66].

4.1 Decreasing Acceptance and Non-use of a Social Robot

Based both on self-report and observational use data, we found that children's acceptance of a social robot decreases over time. Earlier studies reported similar patterns, but included a small sample [43], let children interact freely with the robot only in groups [22, 41, 42], centered on the family rather than the child as the main user [10, 44], or did not explicitly discuss decreasing use [6]. With its rather big sample, rather elaborate longitudinal time frame, and double measurement of robot use, this study thus goes beyond previous studies and demonstrates more generally a significant decrease in children's acceptance of social robots over time.

In general, children were highly interested in the robot for 2 weeks. Use, however, decreased strongly in the period between 2 and 4 weeks (i.e., after T2). This is an important observation as, typically, children adopted the social robot, but either fully stopped using it later or used it considerably less than in the beginning. This finding calls for more longitudinal research in CRI, which echoes what scholars have recently identified as one of the problems of robot studies in HRI [5]. When studying acceptance only cross-sectionally or with a very limited time frame, one can wrongfully conclude that children accept the robot, while over time acceptance may reduce considerably. Such misinformed conclusions can have far-reaching consequences, notably a positivity bias about children's acceptance of social robots. As a result of such a positivity bias, researchers may focus too much on explaining children's enjoyment and enthusiasm for robots rather than

also dealing with children's discontent and frustration (for a similar claim, see [45]). Robot manufacturers and designers may erroneously expect their product to succeed when, at least over time, it may fail to find its place in children's play environment (for design opportunities to sustain engagement in longitudinal CRI, see, e.g., [9, 71]).

4.2 Different Types of (Non-)Users

Generally, the literature on children's acceptance of social robots suggests that, simply put, there is a very large group of users and a very small group of non-users [19]. Our study qualifies earlier research and offers a more nuanced account of types of users. In line with earlier research (for an overview, see [19]), only very few children rejected the robot (i.e., stopped using it after 2 weeks, prior to actual adoption). Most children thus initially adopted the robot, which held for both the observed and self-reported data. In contrast to earlier research, however, the observed data showed that the majority of children did not use the robot consistently over time but could either be classified as discontinuers (i.e., after adopting the social robot, they stopped using it at a later point) or as resumers (i.e., they stopped using the robot at one point but later started using it again). One may argue that the category of resumers is an artifact of the research process in the sense that children resumed use knowing the study would end (see also [41]). This, however, seems unlikely as we did not communicate the end date of the study to children in advance and told them at the start that they could keep the robot after the study. It is important to note that, despite our efforts to mimic a naturalistic robot-acceptance process, the design of our study precluded us from identifying children who choose to not use the robot at all (i.e., *passive rejecters* or *resisters*) because rejection of the robot may have also meant that children did not want to participate in the study. However, this group is probably small, given children's initial enthusiasm to interact with robots as shown in earlier research [22, 23]. Moreover, we were unable to identify children who are prevented from access to a social robot [25] because we provided them with the technology.

Whereas children thus seem to initially adopt a robot, only a small group of children fully accepted the robot in that they used it regularly over the course of 8 weeks. This merges with research on children's use of a social robot in a domestic environment [44], as well as research on children's play practices in general (e.g., [50]). Our identification of a significant group of resumers as a user type of social robots contributes to a better understanding of robot acceptance both in CRI and, more generally, in HRI. At least for children, it seems important to conceptualize robot acceptance as hybrid, and to also include—next to users and non-users—a category of resumers when studying acceptance of social robots longitudinally.

In the present study, we employed a deductive, theory-based approach to classify children's trajectories of longitudinal acceptance and non-use of social robots. An analytical alternative is to inductively identify characteristic trajectories, using modeling techniques such as **Latent Class Growth Analysis (LCGA)** or Latent Growth Mixture Modeling (LGMM) (see, e.g., [72]). These techniques are well-suited to classify trajectories when a deductive classification is difficult, which may be the case due to a lack of theory and/or because a high number of idiosyncratic trajectories exists. A deductive approach was appropriate in this study because theories of technology and robot acceptance have identified main types of users (i.e., users, rejecters, discontinuers, and resumers). Moreover, the range of possible trajectories was restricted as we investigated acceptance across four waves. Finally, our deductive approach was also expedient to identify small groups of users, which may be hard to detect with inductive classification procedures.

4.3 Reasons for Non-use of a Social Robot

In line with the novelty-effect and expectation-experience gap explanation [24, 44, 54], loss of interest in the robot, disenchantment by the robot, and unsatisfied needs were commonly mentioned

reasons for non-use. This result largely merges with earlier research [6], which showed the effect of children's personal interests on the longitudinal interaction. Our study demonstrated that, at least for children, there are also other—more important—reasons for non-use. Across all waves, children most often indicated that they rather played with other things than the robot, which for T3–T5 was the most dominant reason for non-use, followed by a lack of motivation to use the robot.

These findings may also explain the marked decrease of robot acceptance: Apparently, Cozmo was unable to sufficiently attract children over a longer period, given the competition of other toys, which may be an important insight for all those interested in using social robots among children. Moreover, our results suggest that the focus on the novelty effect and the expectation-experience gap as reasons for non-use should be accompanied by more attention to the competition of other toys or media devices in children's homes and children's general lack of motivation to interact with the robot. Future research should thus study children's play practices with robots in general and how social robots relate to other objects, such as toys and digital devices, in particular. Interestingly, whereas previous research identified also technical problems [2, 17] and parental involvement [6] as factors influencing the (longitudinal) CRI, the categories of restrictions/problems and reliance on others did not yield much agreement in the current study. It may be a fruitful endeavor for future research to zoom in on these diverging results and the potential effect of robot type (and more specifically its usability) on these outcomes. Finally, future studies should investigate children's reasons for using robots to contextualize our findings.

4.4 Validity of Self-report and Observational Measures

Given our double measurement of robot use, our study may also provide some initial evidence of the validity of self-report and observational measures of robot acceptance. The general *pattern* of longitudinal use was the same regardless of whether analyzed with self-reported or observed data: Both showed that use decreased. Thus, for identifying patterns of acceptance over time, self-reported data may seem acceptable. However, the results also showed that robot use remained stable after 6 weeks when based on observed data, which was not the case for the self-reported data. Moreover, across all waves, self-reported use was significantly higher than observed use. Whereas there tends to be a floor effect for the observational data (i.e., use was already very low at T4), it also seems that children consistently over-report their own use of the social robot. This could result from a social-desirability bias (see, e.g., [19, 54–57]), but it can also be an overestimation of their own robot use due to children's still developing cognitive skills (see, e.g., [73]). In any case, our results suggest that if researchers are interested in a precise measurement of children's robot use at a particular point of time, observational measures are preferable. Moreover, our results suggest that previous estimates of robot use based on children's self-report measures may be considered with some caution. This finding is in line with a recent meta-analysis showing only moderate associations between self-reported and logged digital media use [58].

It is important to note that the group of users was significantly larger in the self-report data than in the observational data, whereas the opposite was true for users that showed some type of non-use (i.e., rejecters, discontinuers, and resumers). According to the observed data, slightly less than 30% of the children used the robot continuously across the full study (i.e., across 8 weeks), while slightly more than 70% of the children showed some form of non-use. In contrast, a little under 50% of the children reported having used the robot throughout the study, whereas the other half reported some form of non-use. If viewing acceptance as dichotomous (i.e., non-users versus users), this would be a rather large discrepancy (28% vs. 46.7%). However, if we consider hybrid use (i.e., *resumers*) as a form of acceptance, the discrepancy becomes less distinct (i.e., 66% versus 60.1%). This notion also merges with the finding that only the classification of *users* and *resumers*

was significantly different when relying on self-report versus observed data. Future research would benefit from applying a more nuanced idea of acceptance, where a hybrid form of use may also be considered acceptance.

Next to the already mentioned social-desirability bias and still developing cognitive skills, there may be an additional reason for the discrepancies in the classification of user types: Children may have used the robot while it was turned off. Children thus reported having used the robot, but this use was not logged by the robot (as it was turned off). Whereas this may seem unlikely, given evidence on domestic use of the Pleo robot [44], we have noticed children petting the robot while it was turned off in our pilot study. Future research would greatly benefit from further triangulation of not just self-report measures, but also observational data based on logfiles created by the robot. Qualitative research may also help to better understand the different findings for self-report and observational data. Finally, children may have a different notion of robot acceptance than how we conceptualized it in this study based on earlier research. Future studies should therefore deal more elaborately with children's understanding of longitudinal acceptance of social robots (i.e., integration in daily life [31]) and may also consider indicators of robot use other than mere frequency measures, such as the duration of use and the type of interaction children have with robots.

4.5 Conclusion and Limitations

Our study has at least four limitations. First, our study focused on the Cozmo robot. Even though Cozmo classifies as a sociable robot and has advanced interactivity with its user, its sociability is also partly determined by the perception of the child [74]. It may thus be that the appearance, functionalities, but also the potential shortcomings (e.g., no natural-language processing) of this robot have influenced children's longitudinal acceptance of the robot. Future research should investigate children's longitudinal acceptance of robots with varying morphologies, functionalities, and sociability. Second, we studied families living in a technologically advanced rich western country, where households are typically replete with domestic technologies. We need more research in diverse cultures to see whether the results of the current study hold. Third, our sample consisted of 8- and 9-year-old children. Given previous findings that age may affect children's acceptance of social robots (for an overview, see [19]), the results can probably not be generalized to other developmental groups. Fourth, due to the sample size and questionnaire length, we opted for predetermined reasons for non-use, which we only presented to children who reported non-use. This procedure may have overlooked other, equally valid reasons for non-use and hindered comparisons to a baseline (i.e., agreement with the reasons when using the robot). More in-depth, qualitative research may help to establish a more encompassing notion of children's reasons for not using or accepting a social robot at home.

Based on a rather extensive longitudinal study and a rather large sample of children, our study demonstrated children's decreasing acceptance of a (domestic) social robot over time, thus validating results of earlier research. Moreover, this study provided more insight into different types of users and reasons for non-use and showed differences between self-observed and observed measures of robot acceptance. Future longitudinal research should aim at replicating and extending our findings to contribute to a more consistent image of children's interactions with (domestic) social robots. In this context, research that focuses on the antecedents of acceptance and different usage categories is especially important to advance our understanding of which exact (personal) factors affect children's longitudinal acceptance of (domestic) social robots.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest. Anki® and Cozmo® were registered trademarks of Anki, Inc. at the time of this study (now Digital Dreams Labs). This research project is

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