Agents Sharing Secrets

Self-Disclosure in Long-Term Child-Avatar Interaction

A THESIS
in Artificial Intelligence

Submitted to the Faculty of Social Science of the Radboud University Nijmegen
In partial fulfillment of the requirements for the degree of
Master of Science in Artificial Intelligence

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5 September, 2016

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September 5, 2016

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Abstract

A key challenge in developing companion agents for children is keeping them interested after novelty effects wear off. Self-Determination Theory posits that motivation is sustained if the human feels related to the agent. According to Social Penetration Theory, such a bond can be welded through the reciprocal disclosure of information about the self. As a result of these considerations, we developed a disclosure dialog module to study the self-disclosing behavior of children in response to that of a virtual agent. The module was integrated into a mobile application with avatar presence for diabetic children and subsequently used by 11 children in an exploratory field study over the course of approximately two weeks at home. It was found that the relative amount of disclosures that children made to the avatar was an indicator for the relatedness children felt towards the agent at the end of the study. Girls were significantly more likely to disclose and children preferred to reciprocate avatar disclosures of lower intimacy. No relationship was found between the intimacy level of avatar disclosures and child disclosures. Particularly the last finding contradicts prior child-peer interaction research and should therefore be further examined in confirmatory research.

Acknowledgements

Theses research is not carried out alone and mine is certainly no exception. I would thus like to seize this opportunity to thank those that have supported me academically, technically, socially, morally, or universally.

I extend my gratitude to my supervisors Joost Broekens, Mark Neerincx, and Pim Haselager. I am particularly thankful to Joost and Mark for the accommodations they made before the project started: to Joost for accepting the role of daily supervisor without having met me and to Mark for making certain that I could carry out the research despite the initial difficulties. I very much appreciate the time that both have taken to discuss my progress, the crucial conceptual input that these discussions produced, and their aid in communicating and negotiating with other members of the PAL consortium. I can confidently say that this thesis would not have been possible without them. I am, of course, also indebted to Pim for ensuring that all organizational matters at Radboud run smoothly. I further thank Khiet Truong for encouraging me to apply for a thesis within the PAL project and for introducing me to Mark and Rosemarijn.

Additionally, various members of the PAL consortium have helped me in the development of the module and in recruiting children for the study. Thanks to Frank and Diego for helping me get started and for always having an open ear for all my system/app related issues; to Silvia and Olivier for aiding me in all matters pertaining to the children; to Uli for explaining ontologies to me, converting my files, and passing some useful life advice in the process; to Bernd for looking into the server problems; to Bert for extracting the Quiz data from the server; to Rifca and Anika for helping me translate disclosures and providing data/pictures from the May-evaluation.

I am most grateful, though, for the aid obtained from unexpected places. Here, I would like to voice my appreciation of the outstanding technical support that I received from Ruud de Jong. I would also like to especially thank Thomas Moerland for his invaluable statistical input and for repeatedly being a friend in need.

It is a bit odd to thank someone for their chronic illness, but it is truly thanks to my brother, Lukas Burger, that I have gotten to experience the incredible feat of diabetic self-management second-hand. In the same breath, I would like to acknowledge the support I have received from my family in general throughout my entire studies. Last but not least, I would like to thank my boyfriend, Volker Strobel, for convincing me that I can do anything by myself and for being my safety net nonetheless.

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1 Introduction

Have you ever done the dishes because your wife asked you to? Taken a class because you thought it would look good on your resume? Worn something not because you liked it, but because you thought your critical mother-in-law would? Or gotten drunk simply because your friends convinced you?

Social relationships often play a large motivational role in our behaviors. But we will obviously not do everything for everyone. How much we like or want to be liked by someone is an important factor. This warrants the assumption that when wanting someone to do something, effort should be invested into the bond with said someone.

Type 1 diabetes mellitus (T1DM) is an autoimmune disease of the pancreas. The illness accompanies diagnosed children and adolescents through various physical and mental stages of development. In the PAL project, a **P**ersonal **A**ssistant for a healthy **L**ifestyle is developed with the aim of increasing the self-management skills of diabetic children (ages 7-14) by supporting them, their caregivers, and health-care professionals in sharing responsibility. The PAL robot and its mobile avatar are intended to function as a pal for the children, helping them accomplish their diabetes-related goals through person- and time-adaptive, engaging interactions. The core of the PAL system includes an embodied conversational agent (ECA) in the form of a robot and its mobile avatar, an Authoring & Control tool for health care professionals, a Monitor & Inform tool for caregivers, and a mobile health application (MyPal) with avatar presence. All these components are intended to connect to a common knowledge base, the *PAL cloud*. The PAL architecture is illustrated in Figure 1.

No child wants to have diabetes mellitus. No child wants to be woken up in the middle of the night to measure blood sugar levels, weigh food every time before eating, or have parents nag that they are not taking their illness seriously enough. Yet, strict adherence to a medical regimen is crucial to prevent many of the health risks associated with diabetes. Ways of increasing the motivation of children to comply with their medication requirements are therefore desirable. Within the Horizon 2020 PAL project, we thus explored the possibilities and limitations of creating a bond between diabetic child (8-12 years) and a virtual companion agent through self-disclosure with the goal of increasing the motivational capacity of the agent.

According to Self Determination Theory (SDT), successful establishment of a social bond between human and agent leads to sustained motivation both to interact with the agent and to engage in activities that the agent proposes. SDT [9] argues that the basic psychological needs for *autonomy*, *competence*, and *relatedness* must

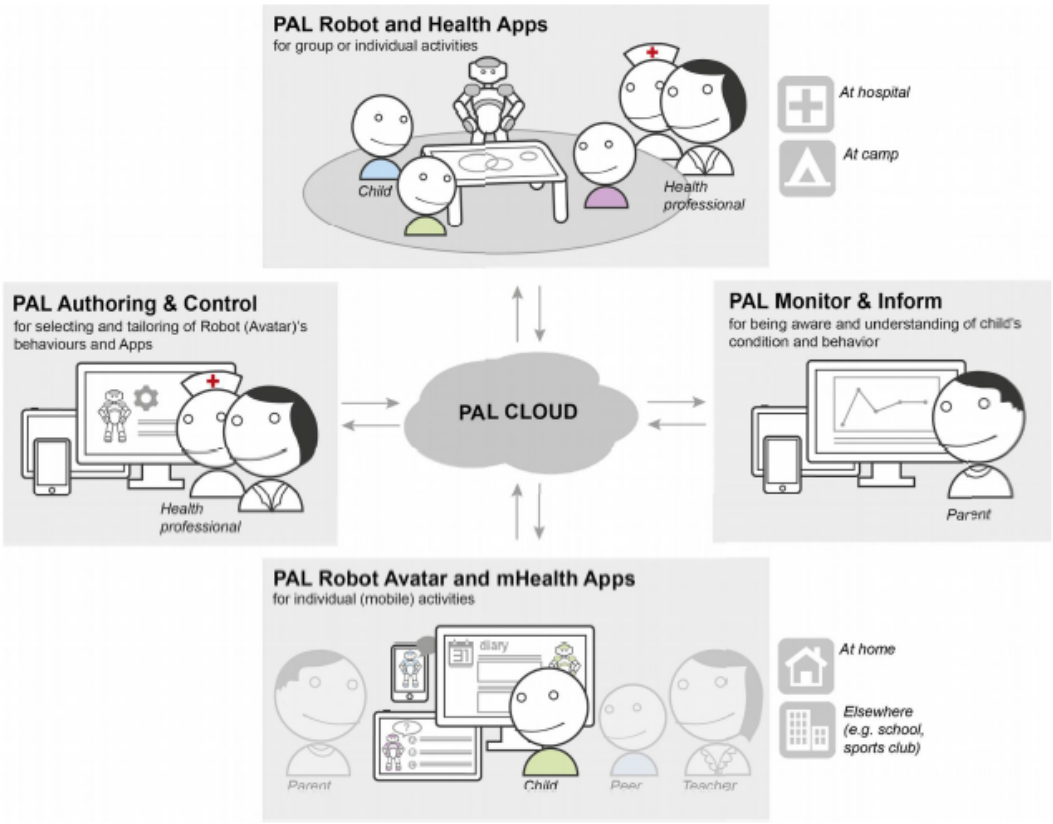


Figure 1: Illustration of the PAL architecture.

be satisfied by the social environment for humans to feel motivated to attempt a task. Relatedness here refers to the feeling that one is accepted and cherished by another individual or community. It comes into play when the intrinsic motivation to engage in an activity is low. More simply put: if we like or want to be liked by someone, we feel more inclined to do what they suggest, even if we are not too fond of the activity itself.

The manner in which such a bond could be established is described by Social Penetration Theory (SPT) [1]. It proposes a directional development of interpersonal relationships whereby the involved individuals first share and explore each others personalities at a superficial level before disclosing more intimate information. Disclosing proceeds along two dimensions: breadth and depth, with *breadth* describing the number of different topics that are disclosed about and *depth* describing the personal value these topics have. Finally, an important determinant of self-disclosure is

reciprocity. This describes the tendency to self-disclose as a result of being disclosed to. Reciprocal disclosures in successfully progressing relationships are usually on a similar level of intimacy.

One of the key interests in human-human self-disclosure research has been the close link between disclosure and liking. Specifically, three persistent disclosure-liking effects have been identified [8]: (a) the more someone intimately discloses to us, the more we like that person, (b) the more we like someone at the outset of the interaction, the more we will disclose, and (c) the more intimately we disclose to someone, the more we like that person.

To the best of our knowledge, no study exists that investigates these effects in child-child interaction. However, when children were asked what a friend is and what differentiates a friend from a non-friend, children older than nine indicated that friends take an interest in each others problems and care for their friend's emotional well-being. Additionally, it is argued that cooperation and the insight that each child should contribute equally to the interaction can be expected in this age group [25]. In line with this, 6th grade children's liking of another child was influenced by that child's ability to match the intimacy level of a disclosure while that of 4th graders was not [22].

Support for the disclosure-liking effect has also been found in the domains of human-robot (HRI) and child-robot (cHRI) interaction. In [18], a computer first disclosed some information about itself before asking the user an interview question. As hypothesized, interviewees shared more intimate information with the computer that told personal information about itself but only if this personal information would gradually increase in intimacy throughout the interview. However, the liking for the computer only depended on the sharing of personal information and was not influenced by the intimacy strategy. When a robot was used to elicit self-disclosures from children, those who were prompted to disclose to the robot described the robot significantly more often as a *friend* than children in the control condition [14]. In [13], a two-month study was conducted in an elementary school with a relational robot capable of identifying children and calling them by name, showing more varied behavior with time, and disclosing personal information as a function of a child's interaction time. It was found that children's desire to be friends with the robot at the end of the study was positively correlated with the interaction time.

In summary, one possibility for sustaining motivation is by leveraging relatedness. SPT provides the necessary tool for establishing relatedness: reciprocal self-disclosure with increasingly intimate content. Human-machine interaction studies further indicate that a bond between user and machine can be created through self-disclosure. Two knowledge gaps can be identified from the related literature. For one, there has

been no empirical investigation of whether and how the sharing of disclosures between user and system contributes to sustaining user motivation over longer periods of time. For another thing, studies on self-disclosure reciprocity in child-child interaction have been conducted mainly in North America several decades ago (compare [7, 21, 22]). It was therefore uncertain whether insights transfer to today's children in Europe or to child-robot interaction. Furthermore, studies conducted within the framework of the ALIZ-E project[1] also showed differences between healthy and diabetic children with regard to robot interaction.

The here described research presents a first step in closing these knowledge gaps. We developed the initial prototype of a dyadic disclosure dialog module (3DM) to gain insights into how and how readily diabetic children respond to self-disclosures of an ECA and to learn about the possibilities of sustaining children's motivation in this way. A situated approach was taken by integrating the module into a mobile application for diabetic children to be used in an uncontrolled environment for a period of two weeks.

The following two broad research interests guided this exploratory investigation:

1. How do children respond to a self-disclosing avatar?

2. What are the possibilities and limitations of establishing relatedness through self-disclosure and motivation through relatedness in the context of the MyPal application?

The upcoming section, Section 2, briefly describes 3DM and how it was developed using the situated Cognitive Engineering method [19]. Section 3 then details how we used the module within the framework of the MyPal mobile application in an exploratory, long-term field study with diabetic children to obtain answers to the above research questions. In so doing, we found that while children did not match the intimacy of disclosures from the ECA, those children who replied more actively to the disclosures also felt more related to the avatar. Furthermore, children were more likely to reciprocate a disclosure when it was of lower intimacy or when the child was a girl. These findings are further elaborated in Section 4. The extent to which these results can provide answers to the research interests is discussed in Section 5. Finally, Section 7 concludes the article by indicating which findings should be revisited in future confirmatory experiments and how the module can be developed further.

[1] `http://www.aliz-e.org/`

2 Development of 3DM

The first prototype of the dyadic disclosure dialog module (3DM) was developed to be integrated into the PAL-system. While it is the ultimate goal of the module to manage the sharing of personal information between agent and child in an adaptive and engaging manner, the first prototype only served the purpose of exploring the disclosure behavior of the children in interacting with an ECA. For this to be possible, it was required that there is actually content that the avatar can disclose. The first section, Section 2.1, hence details the steps taken to develop the disclosure database. This is followed by a description of how the module is integrated into the PAL-system and an explanation of the interaction flow between child and avatar as managed by the prototype in Section 2.2.

2.1 Development of the content

To design suitable disclosures for the embodied conversational agent (ECA), three preliminary steps had to be taken. First, a personality for the avatar was crafted. Second, a background story was written for the robot from which consistent disclosures at various intimacy levels could be derived (see Appendix B for more details on the personality and biography crafting). Third, a scaling method for the intimacy level of both child and avatar disclosures was developed.

2.1.1 Personality

Personality traits were selected by first choosing sensible traits for the given domain:

- *extraverted*: The ECA has to interact with many children and give presentations at camps and in the hospital. Also, it should always be very interested in its interaction partners.
- *conscientious*: Conscientiousness is very important in diabetes self-management. A conscientious ECA can provide positive examples of self-discipline and diligence for the children.
- *warm*: The ECA should function as an *opener* [17], that is, someone who evokes disclosures from the other party. To this end, it must exude trustworthiness.
- *energetic*: The ECA should encourage and motivate children to lead an active lifestyle. Additionally, it should never "not feel" like playing or chatting with a patient.

The Murphy-Meisgeier Type Indicator for Children[2] was then employed for finding a suitable type to integrate these initial traits into one coherent personality. As a result, the ECA was given the type EFJ[3]. Descriptions of this type provided insights into reasonable additional negative qualities (fear of change, inability to handle criticism, high need for praise, people-pleaser) but also additional positive qualities (determination, creativity, curiosity, cooperativeness). It can be hard for diabetic children to cope with their chronic illness psychologically. To match the child's condition, we decided to give the robot one that is not diabetes but similar in its social impact. Since NAO robots are known to overheat regularly, the pal robot was outfitted with a heat condition that regularly interferes with its lifestyle.

2.1.2 Biography

When creating the biography, the goal was to obtain a story that is both in line with the fact that robots are not human and in line with a character that children can embrace[4]. There are three main episodes to the NAO's life:

1. *Nao Nursery:* NAO robots are made in France. When they are not sold immediately, they go to the NAO nursery, which can be imagined as a big playground for robots.
   Rationale: Although the ECA is not needed somewhere in the world straight away, it is not alone. Instead, it is surrounded by many others that are its equals. It is through interactions with peers that children learn to become social beings, to compromise, to become interpersonally sensitive [25].

2. *Family:* The ECA is first acquired by a rich family. There, it experiences the novelty effect first hand. After being enjoyed as a toy for approximately one month, it is banned to the attic for two years.
   Rationale: This period was chosen to give the ECA some depth and to make children feel understood when they share negative experiences.

3. *Hospital:* The ECA was donated by the family to the local hospital. This is where it lives now together with many other care robots and the human patients of course. Here, it is well cared for.
   Rationale: Children should imagine it living in a pleasant environment where it is comfortable. They should also believe that it enjoys its daily work and especially talking to them and playing with them.

[2] `https://www.capt.org/`
[3] `https://www.kidzmet.com/blog/2015/03/08/the-extraverted-feeling-child/`
[4] `http://latd.tv/Latitude-Robots-at-School-Findings.pdf`

2.1.3 Intimacy scaling

To design agent disclosure statements at various intimacy levels and to assess the depth of children's disclosures, a rating scale for disclosure intimacy was needed. For this, the following constraints were identified: (a) the scale should discretize the intimacy continuum, (b) each discrete level should have a clear definition, (c) the scale should have a minimum of three levels [24, Ch. 13], (d) the scale should be neither topical nor example-based. Upon reviewing the relevant child and adult literature on self-disclosure, no entirely suitable intimacy scale could be found. We therefore developed and validated the Disclosure Intimacy Rating Scale (DIRS).

As summarized in [18], intimacy of self-disclosure is directly related to vulnerability of the discloser. Similarly, it is argued in [20] that the social risk associated with disclosing determines the depth of disclosure. With each self-disclosure, we risk "social rejection [or] betrayal" [20, p. 180][5].

$$risk(\mathrm{SD}) = risk(\mathrm{SR}) + risk(\mathrm{B}) \tag{1}$$

with SD := self-disclosure, SR := social rejection, and B := betrayal. Betrayal, here, describes the passing on of information by the recipient to third parties.

Risk can be formalized as the product of probability (P) and impact (I). If we further assume that social rejection does not occur at random but only follows if the disclosure is negatively appraised, we can approximate the risk of social rejection through the risk of negative appraisal:

$$risk(\mathrm{SD}) = P(\mathrm{NA}) * I(\mathrm{NA}) + P(\mathrm{B}) * I(\mathrm{B}) \tag{2}$$

with NA := negative appraisal.

The probability of betrayal, $P(\mathrm{B})$, can depend only on characteristics of and prior experiences with the disclosure recipient. It is therefore independent of the content and cannot be considered in the level definitions.

These considerations initially yielded six intimacy levels. Using these, a total of 6($level$) x 3($topic$) x 2($valence$) x 2($repetition$) = 72 statements were fabricated by the first author with the personality and biography of the ECA providing content and style information. To obtain a first validation of the scale, the statements were rated for intimacy by 10 university students (5 female, $M_{age} = 23$, $SD_{age} = 1.612$) on a six-point scale: only levels *0* and *5* were labeled with *not at all intimate* and *extremely intimate* respectively. We decided against asking adult participants to

[5] The author of [20] actually mentions a third risk: the risk of making the listener uncomfortable. This was ignored here for the sake of a simpler model.

take on the perspective of a child (because results would be questionable in terms of validity) or to rate statements as if coming from a robot (because students are more critical towards the plausibility of a robot expressing emotions and a personality). The biography was hence slightly adapted to fit a 22 year-old student. Before rating, participants were asked to read a persona description of the student and instructions explaining self-disclosure. Intimacy was defined as: "the degree to which a statement reflects information about the self that is sensitive." Further, they were given one example disclosure for each level using a fourth topic. The intimacy levels of the examples was not provided. Participants could thus get an impression of the covered range and the type of statements. Participants found the description of the student and the statements to be believable (the mean believability rating on a 5-point Likert scale was $M_{believability} = 4.3$). The inter-rater reliability was assessed using the two-way random intraclass correlation coefficient with the ten raters, yielding $ICC(2, 10) = .947$. Cronbach's alpha using all items was high with $\alpha = .948$. The Pearson correlation coefficient between the level of an item and the average rating it received across participants was determined to be $r = .85$. To check whether we would also find six intimacy levels back in the item pool, a principal component analysis was conducted on the ratings of all items. Using the point of inflexion as a cut-off criterion [5], four principal components explaining at least 10 % of the variance each and 67 % in total were revealed. *Four* was then used as the desired number of clusters in a k-means clustering algorithm. A post-analysis of the resulting item clusters afforded the four intimacy levels of the DIRS detailed in Table 1.

2.1.4 Self-disclosure database

The current database consists of approximately 150 English disclosures for the avatar at all four intimacy levels. They are organized into the four categories *food*, *school*, *social*, and *sports*. These categories can be matched to those of activities that the child adds to its diabetes diary or to topics of quiz questions. In the diary environment, the child can further indicate its mood. Consequently, the disclosures have valence labels to be matched to the mood indication. In a recent study with high-school students [16], it was found that the expressivity of a robot influenced the students inclination to self-disclose. As a result, each disclosure also has an associated gesture pattern specifically for the NAO. The disclosures are stored as instances of the Disclosure class—a class in the associated ontology described in the following section. Since two of the partner hospitals of the PAL project are in the Netherlands and the study was carried out with Dutch children, all disclosures also have Dutch translations.

Table 1: The four intimacy levels of the DIRS that resulted from the post-analysis.

Risk	**Definition**	**Example**
low	P(NA), I(NA), and I(B) are low or zero: the discloser cannot be evaluated on the basis of the statement or the statement is very common-place.	"I have a lot of brothers and sisters."
moderate	P(NA) is moderate, because statements are more opinionated, but I(NA) and I(B) are low. Negative appraisal can at best take the form of disagreement. The information cannot really be exploited, so that in the case of betrayal, no loss is to be expected. Includes preferences and opinions on activities and objects.	"I like online games in which you have to team up with other players."
high	Either P(NA) is high and both I(NA) and I(B) are low (the content conflicts with the norms of the recipient but does not reflect on the character of the discloser), or P(NA) is low but the content is of great significance to the discloser so that $I(NA)$ and I(B) are high. Disclosures are emotional and may include evaluations of other people.	"I'm really disappointed that my sister will not try yoga with me. She already promised it twice but never followed through."
very high	P(NA), I(NA), and I(B) are high, because the disclosure is at the core of the discloser's self-concept and could easily conflict with the norms of the recipient. In the case of betrayal, great emotional, physical, or material damage may ensue. Social stigmas, self-doubt, deep personal fears and secrets are accumulated on this level.	"Whenever I work really hard or I'm nervous, I start sweating like crazy. I can't get close to people then, because I'm really conscious of how I smell."

2.2 Development of the functionality

2.2.1 Ontology

There are three main classes in the ontology for 3DM: Disclosure, Prompt, and Closer. These correspond to the three types of statements that 3DM relies on. All disclosures have the parameters intimacy level, valence, and topic. Agent disclosures additionally have an associated gesture for the NAO robot and an associated prompt. Prompts are said by the agent to elicit a disclosure from the child. Closers are used to end the off-activity chat and return to the activity. A positive closer is said when the child chooses to disclose something, a negative closer is said otherwise. Since the module is not yet capable of comprehending a child's disclosure, closers are very general statements that make no reference to the disclosure content. The ontology is specified in RDF[6]. The relations between the classes are illustrated in Figure 2.

[6] `https://www.w3.org/`

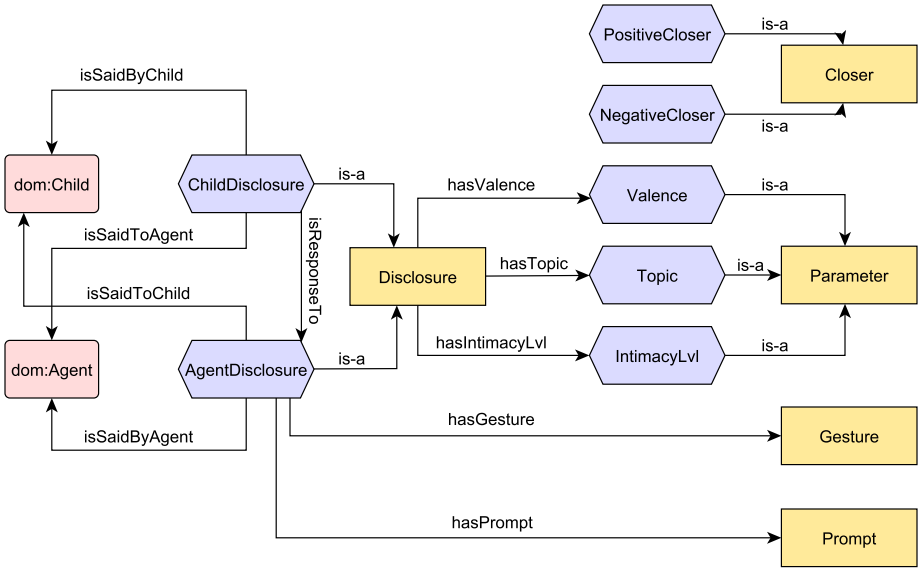


Figure 2: Ontology of the dyadic disclosure dialog module

2.2.2 Dyadic disclosure dialog module

The flow of the disclosure module follows a loop. From the perspective of the user this proceeds as illustrated in Figure 3. While inactive, 3DM waits for a trigger event from the interface. When it receives this, it selects a disclosure and sends it with a gesture to the avatar for rendering. Upon execution, it follows up with the prompt. The interface then provides a pop-up asking the child whether it would like to respond. If the child chooses not to, a negative closer command is sent to the avatar. If the child wants to respond, it can do so in a second pop-up that allows it to type some text. Once the module has received the text, it sends a positive closer command to the avatar. It then simply waits for the next trigger event. In the first prototype, the trigger event was chosen to be the opening of the diabetes diary area of the app. Both closer sentences and prompt sentences contain a placeholder for using the name of the child. It is randomly decided whether to use the name in the prompt, in the closer, or not at all.
An example dialog of the agent (**A**) with a fictional child (**C**) called Maria may look like this:

A(disclosure): "I also go to school! Together with all the other robots at the hospital. Our teachers are doctors and nurses."
A(prompt) : "Enough about me! Tell me something interesting about yourself!"
Interface : *Would you like to tell NAO something?* yes/no
C(selecting) : yes
Interface : *Please provide your response below.* text input field

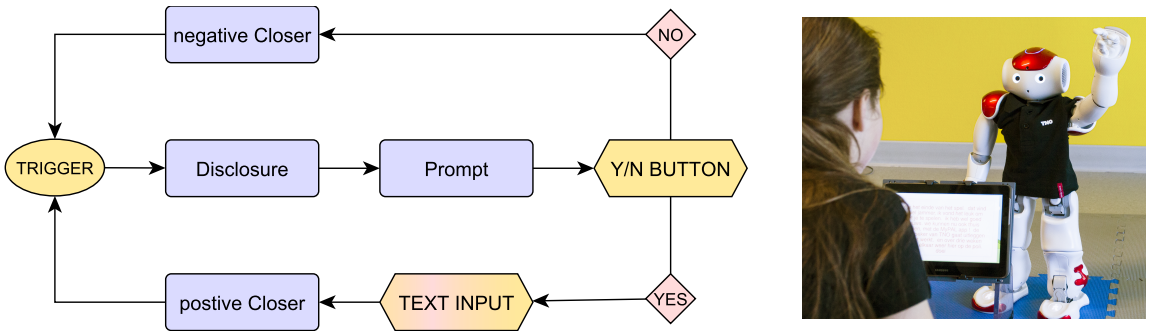


Figure 3: *Left.* Illustration of the 3DM functionality. Interface actions are hexagonal, agent actions are rectangular, and child actions are diamonds. The trigger event has a circular shape. *Right.* A diabetic child interacts with the PAL robot. Photo courtesy of Rifca Peters.

C(typing) : "I had a lot of fun at school today. We played hide and seek during the break. No one found me!"
A(p. closer) : "Thanks for sharing that with me, Maria!"

3 Method

To investigate how children behave towards the avatar, how they respond to its disclosures, how the interaction changes their feeling of relatedness, and how their motivation to use the application develops over time, a two-week, exploratory field study was conducted. The research questions are briefly repeated, before going into detail on how we strove to answer them.

3.1 Research Questions and Variables

The research questions below were of interest at the beginning of the project. However, due to unforeseen events in the course of the field study, questions *RQ*2 and *RQ*3*c* had to undergo some modification. Additionally, *RQ*5 was dropped completely because the collected data was not rich enough. The necessity for and form of these changes is detailed in Section 3.5 and summarized again in Section 3.6.

After the avatar had disclosed to the child, the child was given the option to respond. For simplicity, interactions in which the child chose to respond are denoted as *active interactions* and those in which it did not as *passive interactions* from here on after.

RQ1 Do children use the application more in June than in May?
Independent Variable: evaluation time (May vs. June)

Dependent Variables: usage consistency, average amount of added content (played quiz questions and diary entries) per day and child

RQ2 How do children respond to the disclosures of the avatar?

(a) When children actively respond, can the intimacy level of the child disclosure be predicted from that of the avatar disclosure?

(b) Is there a relationship between the intimacy level of the avatar disclosure and whether children choose to respond?

(c) What (if any) role do age and gender of the children play in how intimately children respond to the avatar?

Independent Variables: disclosure intimacy of robot, age of child, gender of child
Dependent Variables: disclosure intimacy of child, response/no-response choice of child

RQ3 How does the relatedness between the child and avatar depend on:

(a) the amount of disclosures the child heard from the avatar

(b) the amount of disclosures the child made to the avatar

(c) the relatedness before the intervention

Independent Variables: number of active interactions, number of passive interactions, relatedness before the study
Dependent Variables: relatedness at the end of the study

RQ4 Is relatedness a good predictor for children's motivation to use the application?
Independent Variables: relatedness at the end of the study
Dependent Variables: consistency, amount of added content (diary entries, quiz questions)

RQ5 Is there any indication for an optimal strategy in changing the intimacy level over time? (e.g. should it gradually increase?)

3.2 Participants

Participants in the study were 11 diabetic children between the ages of 8 and 12 ($Mean_{age} = 9.91\,years$, $SD_{age} = 1.08\,years$, 6 girls). All participants had previously interacted with the MyPal application at home for 2-4 weeks in May of 2016. After

this initial evaluation, children were asked whether they would like to participate again in June after some changes had been made to the avatar. Children who expressed their interest were contacted by phone in the second week of June to explain the purpose of the study and to determine a possible time to meet. This method was chosen over recruiting new children for several reasons:

1. Recruiting a sufficient number of diabetic children in the target age range with no prior PAL experience from the partner hospitals was not possible.
2. Recruiting from different sources would have taken more time than could be allotted within the time-frame of this project.
3. The prior experience allowed us to compare motivation with and without the new module within subjects. However, due to the unavailability of the module in May combined with the extensive planning that these field studies require, counterbalancing was not possible.

An important participation criterion was that children had to have been diagnosed with diabetes at least six months prior to the evaluation in May to avoid any influence of effects (psychological, lifestyle, family relations) of a recent diagnosis.

3.3 Measurements

3.3.1 Relatedness between child and avatar

It was originally intended to measure relatedness exclusively with a subset of the questionnaire from the May-evaluation. It was hoped that this would permit a comparison between how related the children felt after using the application with and without the disclosure function and hence provide a baseline measure for relatedness. The comparison could then give an indication of the added value of the module.

After administering the initial questionnaire to children, however, it became evident that it was not sensitive enough to capture different attitudes of children towards the robot. A ceiling effect was obtained on all questions regarding relatedness. As a result, *RQ3c* had to be reconsidered. Since the same ceiling effect was found on the post-questionnaire of the May evaluation, the only measure that could be linked to relatedness at the end of the May-evaluation was the usage consistency of children during the evaluation: if children were not consistent, they were probably also not feeling related to the agent and vice versa. It was therefore decided to use the May-consistency as proxy for the pre-evaluation relatedness measure if a strong correlation between June-consistency and post-evaluation relatedness would be found.

To obtain a useful assessment of the post-evaluation relatedness, the subscales *Companionship* (how much the child enjoys spending time with the avatar), *Reliable Alliance* (how trustworthy the avatar is in terms of disclosure), and *Closeness* (how attached the child feels to the avatar and how much the child believes that the avatar reciprocates this connection) from the Friendship Qualities Scale [4] were added as additional questions to the post-questionnaire with slight modifications. The *Help* subscale was not applicable due to lack of interaction of the avatar with the physical world of the child (e.g. "If I forgot my lunch or needed a little money, my friend would loan it to me."). Similarly the *Conflict* and *Transcending Problems* subscales could not be used, because it is hardly possible for conflict to arise between child and avatar within the context of the application. The questions can be found in the final questionnaire in Appendix G.5 (Questions 4-14).

3.3.2 Intimacy of disclosures

In a post-analysis, the disclosures of the children were scaled for intimacy on the same scale as the disclosures of the avatar. This was done by two independent raters.

3.3.3 Motivation

To determine children's motivation to use the system, both indirect system usage measures and direct subjective measures were gathered. In terms of system usage, the following measures were made:

1. the number of times a child chose to respond
2. the amount of content a child added to the app while interacting (quiz questions, diary entries, and active disclosure interactions)
3. the consistency with which a child used the application. This was computed per child by dividing the number of active days (days when children interacted with the app) by the number of total possible use days. An alternative formula for the consistency is given by [15] as:

$$consistency = \frac{n_{content}}{\sum_{j=2}^{n_content} d_j - d_{j-1}} \tag{3}$$

where $n_{content}$ denotes the total count of days on which a child added content and d_j is the index of a day where content was added (e.g. if a child added content for the first time on the 8th day of the study, $d_1 = 8$). This consistency can hence be interpreted as the inverse of the average amount of days

that passed between two days on which content was added. While the formula does relatively accurately capture consistency when children use an application actively, it fails in more extreme cases. For example, if a child uses the application actively on the days $d_{j=1} = 7$ and $d_{j=2} = 8$, i.e. only for two days ($n_{content} = 2$) but two days in a row, it would receive a consistency score of $\frac{2}{8-7} = 2$. A child, however, who used the application for only three days in a row ($n_{content} = 3$) on days $d_{j=1} = 7$, $d_{j=2} = 8$, $d_{j=3} = 9$ obtains a consistency score of $\frac{3}{(9-8)+(8-7)} = 1.5$. This is unintuitive. A child that was active for three consecutive days should be modeled as at least as consistent in its usage as a child that was active for two consecutive days. As a result, the simpler consistency measure of $\frac{n_{content}}{n_{total}}$ was used in this study.

The direct, subjective measures consisted of questions taken from the May-evaluation asking the children how much they played with the application, how much they enjoyed using it, and whether they would like to continue using it. They are included in the post-evaluation questionnaire that can be found in Appendix G.5.

3.3.4 Participant traits

Age, gender, time of diabetes onset, and any comorbidities of the children could already be found in the data from the May-evaluation and did thus not need to be measured again.

3.4 Materials

3.4.1 Technological

1. Tablet Computers: A set of Lenovo tablet computers running Android was bought for the May-evaluation and further evaluations of the PAL project. Tablets were reset to factory settings after the May-evaluation and the new version of the MyPal application was installed on the tablets prior to meeting the children for the first time.

2. NAO robots: The physical robot was used for three reasons. For one, it was found throughout the study that children were not producing sufficient data with the avatar to determine how they match the intimacy level of disclosures. As a result, the real robot in the final interaction session also disclosed and asked children to reply (see Section 3.5.3 below). Also, in the ALIZ-E and PAL projects, it was found that children greatly enjoy and look forward to interactions with the robot. Thus, a final interaction with the robot served

as a form of reimbursement for the children's efforts in the June-evaluation. Finally, an interaction session with the robot at the end of the study allowed the children to say goodbye to their *friend* and enabled mental closure.

3. Audio Recording Soft- (Audacity) and Hardware (Focusrite Scarlett 2i2 USB interface and SE Electronics X1 Microphone): The initial interview was audio-taped. Although it was intended to make further audio recordings of the final interaction with the robot and the final interview, we refrained from it. This choice was made because during the initial interview, it was noticed that some children were inhibited in their responses by the recording: they would only be willing to point at their chosen answer on the questionnaire, or only shake or nod their head to indicate (dis-)agreement, and would afterwards ask if they could hear their recording again.

3.4.2 Functional

1. MyPal Application: The app consists of three main domains—the quiz, the diabetes diary, and an overview of current and achieved diabetes-related objectives of the child. To obtain an impression of the look-and-feel of the application and especially the disclosure loop, screenshots can be found in Appendix H. Unlike in the May-evaluation, when children in June opened the diary, the avatar started the disclosure loop provided that the child was not using the application offline.

2. Hangman Game: For the final interaction between child and robot, a hangman game was programmed with the NAO robot. This included a brief initial dialog in which the robot introduced itself. It then disclosed four times to the child, each time encouraging the child to also disclose, before moving on to the actual hangman game. Children played hangman by guessing a letter and the robot would let them know whether their guess was good or not. The word, the hangman figure, and incorrectly guessed letters were displayed on a laptop screen. The script for the interaction is included in Appendix G.6.

3.4.3 Questionnaires

In total three questionnaires were used in the evaluation.

1. Initial Questionnaire The initial questionnaire was administered to children in the form of a semi-structured interview. It consisted of questions concerning

children's relationship to the avatar, their understanding of robots, their impression of how much they used the application in May, how much they enjoyed using the application in May, and whether they would like to continue using the application. Audio recordings of the interviews were made. Appendix G.5 illustrates the final questionnaire. The initial questionnaire was identical with the final one but excluding question 4-14.

2. Intermediate Questionnaire The intermediate questionnaire was sent to the families by e-mail approximately one week into the evaluation period. Questions regarding the new functionality and subjective impression of app usage were asked. The questionnaire can be found in Appendix G.4.

3. Final Questionnaire The final questionnaire was the same as the initial questionnaire plus the questions from the Friendship Qualities Scale to better assess children's feelings of relatedness. The questionnaire can be found in Appendix G.5.

3.5 Procedure

The procedure that was followed in this study closely resembles that of the May-evaluation. Children and their parents were contacted by phone in the second week of June to inform them of the purpose of the study, to explain the details of the procedure, and to invite them to participate again. If interested, parents were asked for their email address to receive an information letter and to then schedule an initial appointment.

3.5.1 First appointment (home).

The first appointment took place in the homes of the children. The experimenter visited each of the participating families to administer the initial questionnaire and to return the tablet computers to the children. Unlike in the May-evaluation, it was decided not to include the physical robot in the initial session. Since there was no interest in measures relating to the actual robot, it was regarded as a potentially confounding variable. Also, parents were not actively involved in this study and did not have to complete any questionnaires. After signing the consent form, children were interviewed using the initial questionnaire. Children and their parents were asked whether the interview could be audio recorded. While all parents and children agreed, it was noticed that some children were not comfortable with the recording and could not speak freely when aware of the recording. As a result, no

recordings were made beyond the initial interview. Once the initial interview was complete, it was explained to the child that the app now contained a new robot with a different name (Robin). Other than that, the functionalities were the same as in the prior evaluation and they could use it without further instructions. Children were not given any guidelines as to how much they should use the application per day, because we were interested in as natural of an interaction as possible. Finally, parents were given contact details of the experimenter to use in case of technical or other problems/concerns. The information letters and consent form are available in Appendix G.

3.5.2 Intermediate questionnaire (remote).

After one week of using the application, the families were contacted by e-mail with a link to the intermediate questionnaire.

3.5.3 Second appointment (home).

The second appointment was similar to the first appointment. Children were again visited by the experimenter in their homes. The final questionnaire was then administered in the form of a semi-structured interview between child and experimenter. The physical robot was present in its traveling case (thus not visible) but not yet set-up during the interview. After the interview, the child was given a chance to play a hangman game with the real robot before which the robot introduced itself as Robin, telling the child that it lives in the hospital, and asking it to play a short game of story-telling to get to know each other better. In the story-telling game, the robot would make a disclosure randomly at one of the four intimacy levels and encourage the child to disclose in return. When the child was finished speaking it could say a code word to signal to the robot that it was finished. After four rounds of this interaction covering all four intimacy levels, the robot proceeded to explain the hangman game. At the end of each round, the robot would use the word that it had selected to tell another disclosure (e.g. "Hmm, the word was 'fountain'. That reminds me of another story! One time when we were playing outside...") and to again encourage the child to also disclose. In total, four rounds of hangman could be played but children could terminate the game after any of these rounds. Each child heard between four and eight disclosures from the physical robot. Care was taken that there was no overlap with the disclosures that the avatar had already told the child during the prior evaluation period. No sound recordings were made of this game and consequently also not of the disclosures children made during the game.

Disclosures during the final interaction were recorded in the form of notes made by the experimenter.

Before the experimenter left, children were asked to return their tablets. All in all, this final session took approximately 60 minutes.

3.6 Modified research questions

As explained above, the two research questions *RQ*2 and *RQ*3*c* had to be modified. To add to the active interactions between child and ECA, the physical robot was employed as an additional "discloser" in the final interaction session. *RQ*2 was therefore changed to include the type of ECA from which the disclosure came as an influencing factor (in addition to age and gender) in the intimacy of a child's response. From here on after, a clear distinction will therefore be made between the terms ECA, avatar, and robot in the context of disclosures: *ECA* will be used to refer to the combined disclosures coming from avatar and robot, while *avatar* will denote only those disclosures that were said within the context of the app, and *robot* will denote those at the final interaction session.

Since it was not possible to reliably assess the relatedness of children at the beginning of the June-evaluation, research question *RQ*3*c* was changed to: If there is a stong, positive relationship between usage consistency in June and relatedness at the end of the June-evaluation, are the children that feel more related to the avatar also already more consistent in their app usage in May (indicating relatedness at the beginning of the June-evaluation)?

Both these changes lead to limitations in terms of the generalizability of results. These will be discussed in Section 5. It must be emphasized that making such alterations was only accepted because of the exploratory nature of the study. In the following section, the results are presented.

4 Results

This section details the various analyses[7] that were conducted to answer the identified research questions with the data gathered in the May and June evaluations. We adopted $\alpha = 0.05$ as the significance threshold. Since it is difficult to decide whether a variable is likely to be normally distributed in the population on the basis of only

[7]All analyses and plots were made using R-Cran version 3.2.4. Heatmaps were created using MATLAB 2014a.

Table 2: Activity comparisons between May and June evaluation based on $n = 11$ observations using a Wilcoxon signed rank test, with W and r signifying the sum of signed ranks and the effect size ($z/sqrt(2n)$) respectively.

Data	**Response**	**W**	**p**	**r**
Quiz & Dairy	$\overline{Act_{day}}$	57	.032	−.65
	$Consistency$	40	.221	−.36
Dairy	$\overline{Act_{day}}$	45	.083	−.52
	$Consistency$	38	.308	−.31

11 values (there were 11 participants in this study), it was decided to use the more conservative non-parametric test statistics whenever applicable.

4.1 RQ1: May versus June usage

To compare the app usage of children between the May and June evaluation, two different measures were used: the usage consistency (how regularly did children add content to the application?) and the average amount of added content per use day (how intensively did children use the application when they used it?). Averaging by the number of days that a specific child used the application was an important means of standardization, because the May-evaluation ran over the course of approximately 3 weeks, while the June-evaluation only had a duration of approximately 2 weeks. Furthermore, in both evaluation periods, the amount of days a specific child had access to the app varied.

Measures relating to the disclosures were not included in this comparison because they were not available in the May-evaluation. The inclusion of the quiz questions in the added content measure is debatable. Children liked the quiz very much, frequently indicating in interviews that it was their favorite part of the application. However, the game only had a limited number of questions. Since many children played through most of the questions in May already, and no new questions were added in June, it is only natural that their interest in the game was much less in June. Therefore, the better measure to compare May and June activity on is the amount of diary entries that the children made and the consistency with which they made such entries. For analyses (with and without the played quiz questions), the paired Wilcoxon signed rank test was used. The results are shown in Table 2.

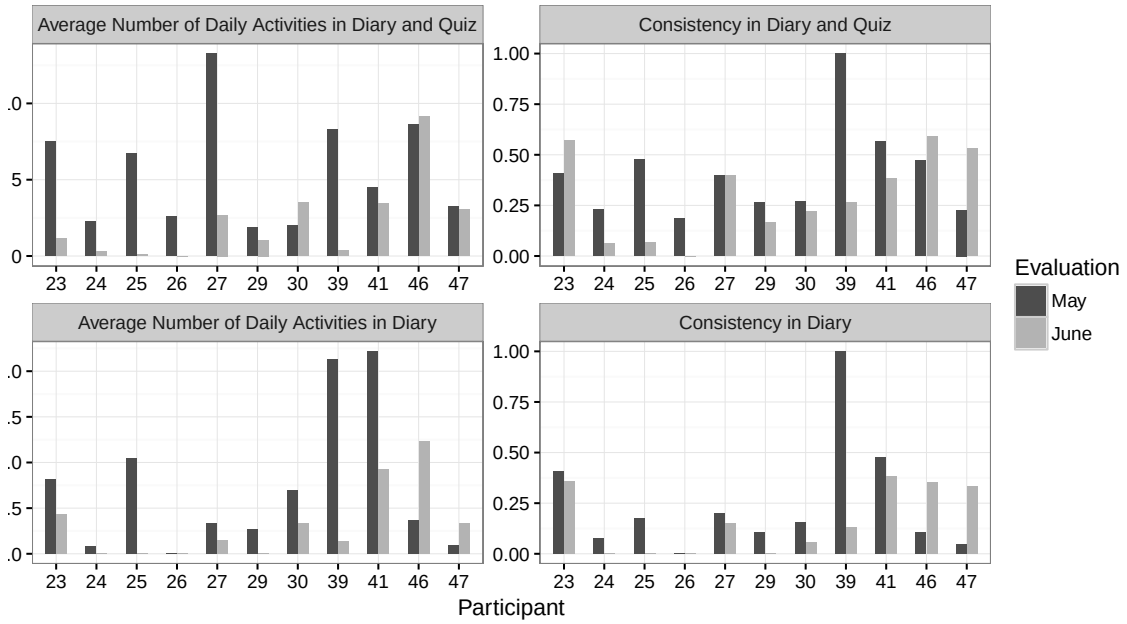


Figure 4: Visualization of activity measures in May and June for each child. The top row contains those measures pertaining to the overall usage (diary and quiz questions) while the bottom row only considered activity in the diary.

4.2 RQ2: Children in dialog with the avatar

Two things were of interest when regarding how children respond to the disclosures of the ECA:

1. When children actively respond, can the intimacy level of the child disclosure be predicted from that of the ECA disclosure (taking into account age, gender, and ECA type)?

2. Is there a relationship between the intimacy level of the ECA disclosure and whether children choose to respond (taking into account age, gender, and ECA type)?

Both ECA and child disclosures were rated by two independent raters on the basis of the intimacy scale described in Section 2.1.3 (the instructions can be found in Appendix G.7). Interrater agreement was assessed with a weighted Cohen's kappa. The unweighted Cohen's kappa only takes into account exact matches in ratings and is best suited when scale values are nominal and mutually exclusive. This is not the case for disclosure intimacy, which was assessed on an ordinal scale in which higher

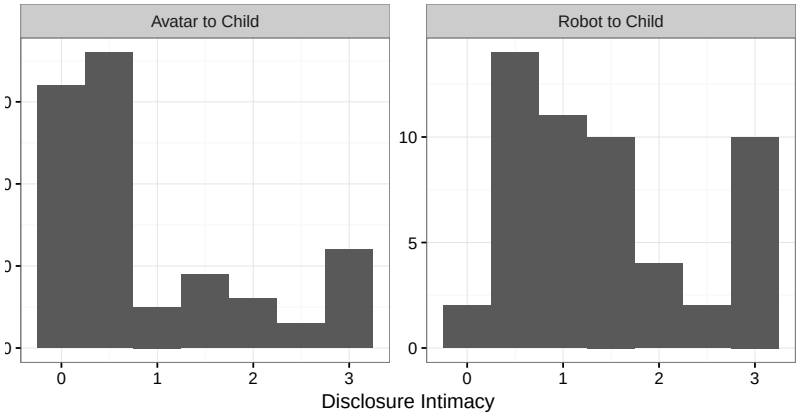
intimacy levels subsume lower intimacy levels. Hence, a weighted Cohen's kappa which squares the deviance between ratings (extent of disagreement) was employed. For the disclosures made by the ECA and the children, agreement was substantial with $\kappa = .707$, $n = 63$ and $\kappa = .697$, $n = 88$ respectively. It was therefore decided to use the ratings of one rater for further analyses. Ratings were not averaged, because this would artificially increase the number of to-be-predicted classes and consequently decrease the number of data samples per class.

It also has to be mentioned that children did not use the application very actively resulting in sparse data. Additionally, there was a set of 'Background'-disclosures (in total 7 disclosures) that provided background information necessary for the comprehension of some other disclosures. Since they concerned just basic, factual information, they were all of very low intimacy (level 0 or 1). The avatar disclosed these before moving on to randomly select from all remaining disclosures. As a consequence of this behavior and the children's overall little usage of the application, the distribution of ECA disclosures over the various levels is not uniform. The top two rows of Figure 5 depict the various distributions of disclosure intimacy (average of both raters) from the two types of ECA and the respective response intimacies of children.

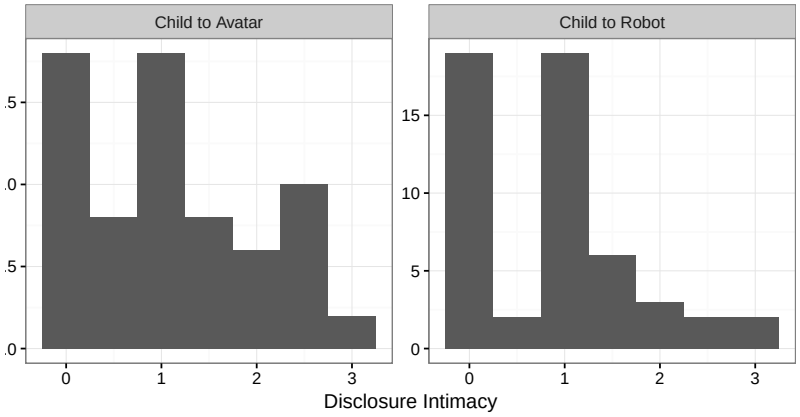
4.2.1 Child actively responds

To see which effect the intimacy level of the ECA disclosure had on the intimacy of the child disclosure, linear models were fit to the data. The data is hierarchical with disclosures nested within children. As a first step, the need to use a multilevel linear model for the data was therefore determined following [10, Sec. 19.6.6.]. To this end, a model that uses the individual mean intimacy for each child ($AIC = 248.7$) was compared to the baseline model of the overall mean across children ($AIC = 247.1$) using the Akaike's Information Criterion (AIC). Since the AIC is higher for the model that allows the intercepts to vary per child, there is no variation in the data that is attributable to the random factor *child*. For the sake of a simpler model, it was therefore decided not to fit a multilevel model. Instead, a cumulative link model was chosen.

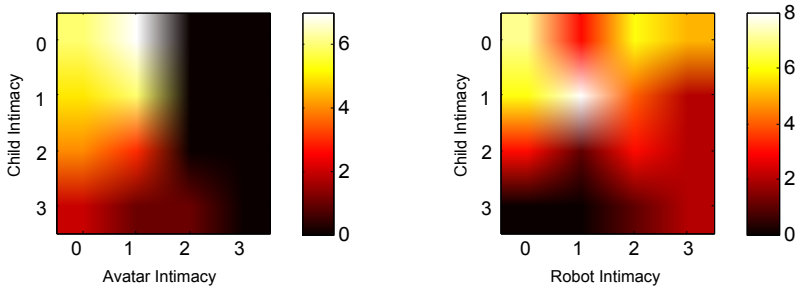
Several predictor variables are of interest, the most important being the intimacy level of the ECA disclosure that preceded the child disclosure. This is followed by the type of ECA (avatar or robot) that made the disclosure. The related literature indicates children's disclosure intimacy may depend on their age and gender, these variables were also included in the model. The predictors of interest were therefore: Robot.Intimacy, ECA.Type, Child.Age, and Child.Gender.



(a)



(b)



(c)

Figure 5: Figure 5a shows the distribution of disclosure intimacies separately for the avatar and the robot. This is obtained by taking the mean of both raters. Figure 5b illustrates the distributions of child intimacy in response to avatar and robot. Figure 5c shows the contingency matrix of avatar/robot disclosure intimacy and respective child disclosure intimacy as a heat map. The top left corner represents the amount of child disclosures of intimacy level 0 that were made in response to agent disclosures of level 0. Heatmap values were based on the ratings of one rater.

The model is given by the following equation:

$$logit(Child.Intimacy_i \leq j) = \theta_j - \beta_1(Robot.Intimacy_i) - \beta_2(ECA.Type_i) \\ -\beta_3(Child.Age_i) - \beta_4(Child.Gender_i)$$

with $i = 1, \ldots, n$ and $j = 1, \ldots, J$. There were $n = 88$ disclosure exchanges between the children and the robot and $J = 4$ different intimacy categories. Two assumptions are of interest for this model: multicollinearity of the predictor variables and proportional odds. Robot.Intimacy and Child.Age were not correlated ($r = .05$), the other variables are nominal. The latter assumption was assessed using the graphical method proposed in Harrell [12, p.335]. None of the predictors meet the assumption of proportional odds. To account for this, a more lenient model, allowing predictor β's to vary for each value of the outcome variable, would need to be adopted. However, this would require estimating parameters on even fewer data samples. Given the already sparse data, and the fact that there are no theoretical reasons for assuming that any of the predictor variables would affect one cumulative split of the model differently than another, it was decided to use the simpler model from the equation above. None of the independent variables played a significant role in the prediction of intimacy of child disclosure. The results are displayed in Table 3. While the model's $AIC = 227.95$ indicates a better fit to the data than the baseline model, the condition number of the Hessian is very large ($H_{cond} = 5.2e^4$). This number gives an indication of the identifiability of the model [6, p.7], with numbers larger than $1e^4$ signifying poor identifiability. This could probably be remedied by additional and more balanced data meeting the assumption of proportional odds. Prediction probabilities were not determined due to the poor fit of the model.

4.2.2 Child chooses whether to respond

Children were given the choice whether to disclose to the avatar in response to a disclosure from the avatar. It was therefore also of interest to investigate whether their choice to reciprocate depended on the intimacy level of the disclosure.

Much the same procedure as above was followed to determine the need for a multilevel linear model. Comparison of the baseline model of the mean to one allowing for random intercepts for each child yielded a significant improvement to fit with the latter model ($AIC_{baseline} = 155.32$, $AIC_{child} = 140.00$, $\chi^2(1) = 17.32$, $p < .0001$). Hence, a multilevel model was fit in a forced entry manner.

Table 3: Results of fitting the cumulative link model to predict children's disclosure intimacy from the preceding ECA disclosure intimacy, the type of ECA, the age, and the gender of the child. The first five columns show the log-odds and significance tests using the Wald-statistic. The next set of three columns show the likelihood ratio if the respective predictor is dropped from the model as compared to the full model. The final three columns show the cumulative odds ratios and respective confidence intervals.

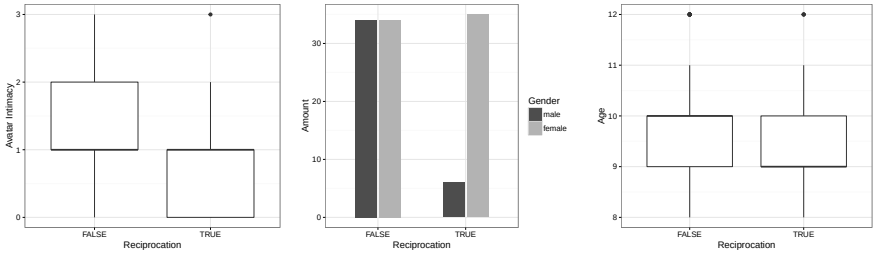
	Coefficients					**Likelihood Ratio**			**Odds Ratio**		
Predictor	*b*	*z*	*p*	*CI*		*AIC*	$\chi^2(1)$	*p*	*OR*	*CI*	
				2.5 %	97.5 %					2.5 %	97.5 %
Robot Intimacy	-.06	-.22	.829	-.60	.48	225.99	.04	.829	.94	.55	1.61
ECA Type	-.25	-.51	.610	-1.20	.70	226.21	.26	.610	.78	.30	2.01
Age	-.07	-.31	.758	-.49	.36	226.04	.10	.758	.94	.61	1.43
Gender	.41	.87	.348	-.51	1.36	226.71	.76	.383	1.51	.60	3.85

The multilevel model is given by the equation:

$$\begin{aligned} logit(E[Reciprocation_{i,k}]) = (\theta + \gamma_k) + \beta_1(Avatar.Intimacy_i) + \\ \beta_2(Child.Age_k) + \beta_3(Child.Gender_k) + \\ \beta_4(Avatar.Intimacy_i * Time_{i,k}) \end{aligned}$$

for children $k = 1, \ldots, K$ and measurements $i = 1, \ldots, n_k$ with n_k measurements per child. By adding γ_k to the intercept, the multilevel model permits different intercepts for different children. The simple logistic regression model does not include the γ_k-vector. Dropping the random effect of child ($AIC = 125.37$) and comparing to the multilevel ($AIC = 126.25$) model yielded no significant improvement ($\chi^2(1) = 2.88, p = .089$) with added complexity. As a result, the multilevel model was discarded again for the sake of a simpler model. The fit of the simple logistic regression model ($R^2 = .31$ (Nagelkerke), $AUC = .78$) was significantly better than the baseline model of the mean $\chi^2(4) = 28.10, p < .001$.

Figure 6 illustrates the effect of each predictor separately on the binary variable *Reciprocation*. The interaction term was included because the background disclosures caused disclosures of lower intimacy from the avatar to coincide with the beginning of the evaluation period. The results from fitting the model match with the visual impression. Both the intimacy level of the avatar disclosure and the gender of children significantly predict whether children choose to respond. As can be seen in Table 4, for every unit increase in robot intimacy, the log-odds of a child disclosing decrease by .83. Furthermore, the odds of boys disclosing are 7.59 times lower than those of girls.



(a) Avatar Intimacy (b) Gender (c) Age

Figure 6: The relationship between each of the predictors and the outcome variable *Reciprocation* in the logistic regression model of whether a child chooses to respond.

Table 4: Results of fitting the logistic regression model to the response choice of children within the application.

	Coefficients					**Odds Ratio**		
Predictor	*b*	*z*	*p*		*CI*	*OR*	*CI*	
				2.5 %	97.5 %		2.5 %	97.5 %
Avatar Intimacy	-.83	-1.96	.049	-1.72	-.04	.43	.18	.96
Age	.12	.51	.608	-.35	.60	1.13	.70	1.83
Gender	2.02	3.09	.002	.81	3.41	7.59	2.23	30.27
Avatar Intimacy x Time	-.00	-.15	.878	-.02	.01	.99	.98	1.01

4.3 RQ3: Relatedness

As described in Section 1, Social Penetration Theory posits a strong link between liking and disclosure. It was hence of interest whether the disclosure activity of children was indicative of the relatedness they felt with the avatar at the end of the evaluation period.

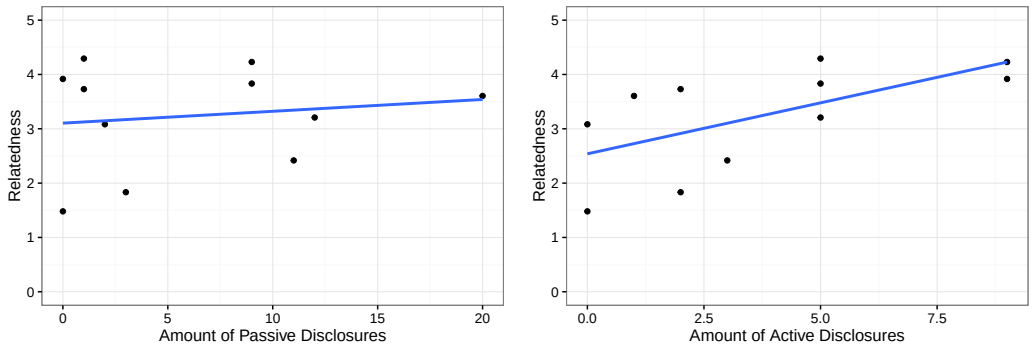
To determine the reliability of the relatedness measure in this study, Cronbach's α was computed separately for each of the employed subscales of the Friendship Qualities Questionnaire ($\alpha_{COMP} = .73$, $\alpha_{RA} = -.41$, $\alpha_{AB} = .84$, $\alpha_{RApp} = .91$). The two items of the *Reliable Alliance* subscale were found to negatively correlate ($r = -.18$). It was thus decided to drop one of the items. For this choice, the overall Cronbach's α of all 11 items was calculated ($\alpha = .89$). Dropping the item "If there is something bothering me, I can tell my friend about it even if it is something I cannot tell to other people" increased the overall reliability of the scale ($\alpha = .90$). Active and passive disclosure counts were standardized for each child with the total number of days that it used the application.

4.3.1 Disclosure behavior and relatedness

To obtain insight into how the two different disclosure behaviors (active vs. passive) relate to the bond between child and avatar, the correlations between the variables could be determined separately. These are illustrated in Figure 7. However, these correlations do not control for the overall activity of children. The relationship between disclosure behavior and relatedness was therefore modeled using linear regression with the predictors *total number of disclosures* and *percentage of active disclosures*. The model is given by the equation:

$$Relatedness = \theta + \beta_1(Disclosures) + \beta_2 \left(\frac{Active.Disclosures}{Disclosures} \right)$$

The two predictors were not correlated ($\rho_S(9) = .10, p = .75$). The model (adjusted $R^2 = .45$) fits the data significantly better than the baseline model ($F(2, 8) = 5.17, p = .03$). The total amount of disclosures was not found to be a significant predictor in the model ($b_1 = 0.98, t(8) = 2.018, p = .08$). The ratio of active disclosures to total disclosures did however significantly predict relatedness ($b_2 = 1.79, t(8) = 2.690, p = .028$). This means that a unit increase in active disclosures ratio (proportionately increasing active and decreasing passive disclosures) while keeping the overall amount of disclosures constant results in a relatedness score increase of 1.79.



(a) (b)

Figure 7: The relationship between the absolute amount of passive (a) and active (b) disclosures of children within the application and their relatedness as indicated on the final questionnaire.

A problem here is causality. Since I was not able to reliably assess the relatedness of children prior to the intervention, it cannot be said whether more active disclosures lead to more relatedness or more relatedness leads to more active disclosures.

4.3.2 Relatedness and activity

Self-Determination Theory argues that relatedness plays a role in motivation. To determine whether the data of this evaluation constitute supportive evidence, the relatedness was correlated with children's overall consistency (how often they used the application) as well as their overall activity (how much they used application). Using a one-tailed Spearman's rank order correlation, a significant relationship was found between the relatedness and the consistency with which children used the application ($\rho_S(9) = .59$, $p = .03$) and the average daily activity ($\rho_S(9) = .64$, $p = .019$). This is an indication that relatedness may positively influence motivation and even be able to uphold it over time.

To test this, a robust two-way mixed ANOVA was also carried out. For this, children were artificially split into two equally sized ($n_{related} = 6, n_{unrelated} = 5$) groups based on the overall relatedness mean. The evaluation period was divided into two halves for each child and their average daily activity (number of active contributions—diary entries, quiz questions, active disclosures—to the application per day) was calculated for each half. Thus, the relatedness constitutes the between-subjects factor and the evaluation half constitutes the within-subjects factor. Figure 8 shows the activity means of each of the $2x2 = 4$ factor level combinations. Variances were equal both across the two evaluation halves ($F(1, 20) = .12, p = .73$) as well as across the two relatedness groups ($F(1, 20) = 1.72, p = .20$). Neither main

(Relatedness: $Q = .90, p = .38$; Evaluation half: $Q = 2.94, p = .17$) nor interaction effects were found ($Q = .90, p = .40$).

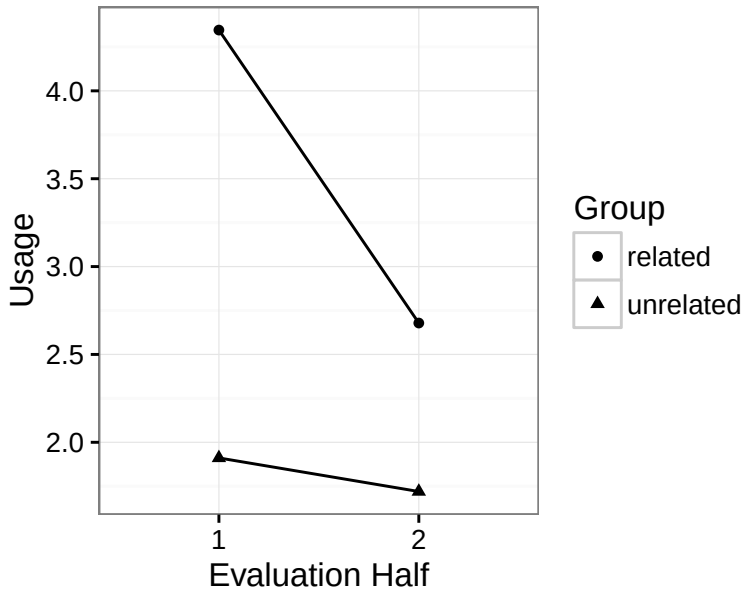


Figure 8: Average number of activities per evaluation half across children that were artificially split into the two groups related ($n = 6$) and unrelated ($n = 5$) based on their indication of Relatedness on the final questionnaire.

Since the data do not provide conclusive evidence for a link between relatedness and children's engagement with the application, children's engagement in May could not be regarded as a proxy measure for their relatedness at the outset of the June evaluation.

5 Discussion

The data analysis resulted in several interesting and partially unexpected findings. In this section, we therefore regard the results in light of the larger context of the study and its theoretical background. The nature of the research was exploratory with the goal of generating new research questions. These will be identified throughout this discussion and summarized again in Section 6.1.

5.1 Disclosure intimacy

The first matter of interest in this study was the relationship between the avatar's disclosure intimacy and whether children choose to respond as well as how they respond if they do. The former only regarded children's behavior within the diary, while the latter also included the robot.

We found avatar intimacy to be a significant predictor in whether children choose to respond with children being more responsive to disclosures of lower intimacy than disclosures of higher intimacy. This result may be limited by the confounding variable *time*. Due to the background disclosures of low intimacy that were disclosed before the robot would move to randomly select disclosures of all intimacy levels, low intimacy disclosures coincided with the beginning of the evaluation period. It is therefore possible that children disclosed more to disclosures of lower intimacy because of the novelty of the feature. Adding an interaction term of avatar intimacy and time as predictor to the logistic regression model did not improve it, indicating that time is not a moderator in the effect. Due to the small amount of data, however, it cannot be entirely excluded. If the effect is not due to the confounding variable, there are several other possible explanations. For one, children may have felt the disclosures of higher intimacy to be too much too early. It may also be that they were aware that they should match the higher intimacy but did not know anything of higher intimacy to share. The overall rather low intimacy of child disclosures that can be seen in the two heat maps in Figure 5c could be regarded as additional evidence for this. However, in the May-evaluation as well as in the focus group of the ALIZ-e project [2], parents and children stated that they would appreciate a "buddy" robot with whom children can talk about their troubles. It is therefore unlikely that children are entirely untroubled, especially when taking into consideration that they are chronically ill. Instead their troubles may not be salient enough when interacting with the app, they may not trust the avatar sufficiently despite saying so in questionnaires, or the avatar may be too limited in responsiveness. A future study could be conducted to systematically discern these possibilities.

Another significant predictor in children's decision to disclose was the gender of the child with boys making substantially fewer disclosures to the avatar than girls. Three of the five participating boys barely used the application (Participants 24, 26, and 29). Of the two boys that engaged with MyPal, both disliked the module, one because he could not get directly to the diary, the other because he did not want to talk to the avatar. For the six girls, two also showed very little usage. However, all girls expressed their liking of the module in questionnaires. Since the sample was very small, it is not clear how this generalizes to larger populations. Before drawing conclusions, the gender effect should be re-examined in a confirmatory study.

Finally, when children responded to the ECA, no pattern could be found regarding prior intimacy of the ECA's disclosure, the type of ECA, the gender, or the age of children. This contradicts prior results from child-peer disclosure behavior, in which children in the same age range as in the current study either relatively or absolutely matched the intimacy of the discloser when reciprocating [23]. From the heat maps, it appears that children are conservative in their replies, tending more towards the lower two intimacy levels regardless of the ECA's intimacy level. This result must be considered with caution, since it is based on sparse, unbalanced data. Furthermore, a problematic influence in the interactions may have been the lack of privacy given to the child when disclosing. In interactions with the physical robot, the experimenter was present and due to the spatial arrangement of some of the children's homes, it was not always possible to isolate the children from parents or siblings or ensure that no disturbances (such as family members coming home) would occur. It is also possible that children experienced similar lacks of privacy when interacting with the application or that some of the disclosures occurred in the context of children demonstrating the application to others.

All in all, the data does not paint a coherent picture with children disclosing more actively to disclosures of lower intimacy but not following any particular pattern when they do disclose. The external validity of results is not given because of the small sample size of both children and disclosures as well as the unequal distribution over different intimacy levels. Furthermore, the nature of the study led to potential influences of confounding variables. Particularly since the latter result does not match with prior findings from child-peer interaction, it is important to investigate again whether it is attributable to the replacement of the human peer with an artificial one or if other variables influenced children's true intimacy tendency.

5.2 Disclosure, relatedness, and usage

The second matter of interest was the chain of *disclosures* → *relatedness* → *motivation* that is indicated by the two human factors theories (Self-Determination Theory and Social Penetration Theory) constituting the theoretical backbone of this work. For the link between disclosure and relatedness, we found that the ratio of active disclosures to total disclosures significantly predicted the relatedness. This means that the percentage of active disclosures that children make can be regarded as an indicator for how related they feel towards the agent. A persistent finding in the related adult-adult interaction literature is that we like those more who disclose to us more [8]. This was not supported by our results, which show that it is actually the active disclosing that matters in this context. Since the initial questionnaire that we

administered to children was not sensitive enough to capture their relatedness at the outset of the study, causal inferences regarding the finding cannot be made, i.e. it is unclear whether disclosing more led the children to feel more related or whether they disclosed more because they felt more related. This should be investigated again in a controlled experiment.

When regarding the link between relatedness and usage, we found no interaction effect across the two different evaluation weeks. Thus, whether children felt more or less related to the agent at the end of the evaluation did not affect their usage of the system differently in the first versus the second week. However, it must be kept in mind that the artificial split of participants into two groups means that the between-group comparisons of the robust ANOVA are based on only 5 to 6 participants. Therefore, it is more sensible to rely on visual inspection and the correlations. In so doing, we find that while more relatedness is associated with more and more consistent usage, the usage of the related group decreased substantially from the first to the second evaluation half. This is in-line with the Self-Determination Theory view on the role of relatedness in motivation, namely that relatedness is a factor in motivation, but not sufficient for it. By extension, this implies that the other two pillars of intrinsic motivation (autonomy and competence) may not be optimally met by the application. The usage curve over time from the May-evaluation supports this impression as do the claims of children in interviews and on questionnaires. While children greatly enjoy the quiz game in the application, the lack of new questions in the June-evaluation made it less attractive. The diary in the application was often stated by children as their least favorite aspect (both in May and in June). As a result, the application as a whole may not have been attractive enough for children. Several children's ideas for app improvements included the addition of new games. While this should not necessarily be taken literally, it signals children's expectation to be entertained by MyPal. While the app may compete with other apps on a very narrow market in terms of its ultimate goal (supporting diabetic children in acquiring self-management skills), the amount of applications competing for children's attention and engagement is a much larger one; one that cannot be underestimated.

Comparing the May-evaluation activity to that of the June-evaluation, children added more content in May than in June both in quiz and diary combined as well as only in the diary. The difference of the latter is not significant, but visible in Figure 4. However, children did not differ significantly in usage consistency in both evaluations. This indicates that the large amount of added content in May was mainly due to the novelty of the application. Since no control group was used, the approximately equal consistency overall between May and June evaluation cannot be

attributed to the module, i.e. it is unknown whether a group of children continuing to use the application without the module would have shown a drop in consistency. Looking at the two consistency plots in Figure 4, it becomes apparent that there are large individual differences. Participant 39, for example, contributed to the application daily in May (even to the diary) but only on one-forth of the days in June. This child also indicated in the intermediate questionnaire that the module was a nuisance for him, because it prevented him from easily accessing the diary. One other child (P. 27) also remarked this. Participants 46 (youngest participant, 8) and 47 (oldest participant, 12), on the other hand, both made more diary entries more consistently in June than in May. For participant 46, this is clearly attributable to the module, because the participant pointed this out in the intermediate questionnaire and was also one of the most active disclosers. Participant 47, however, implied in the questionnaires that he did not appreciate the module much and especially did not like sharing disclosures with the avatar. It is therefore likely that additional variables that were not measured, such as more free time, contributed to his higher consistency. Thus, no clear pattern across children emerges, further supporting the need for personalization of module functionality.

In summary, it can be said that there is a link between actively disclosing and relatedness but the causal relationship needs to be further investigated. More related children did not maintain their higher initial levels of usage over time, but were using the application more than less related children.

6 Directions for further research

The nature of the study required flexibility and some adaptations had to be made to the protocol. Nonetheless, several interesting results were found. Children prefer to disclose to avatar disclosures of lower intimacy levels and girls are significantly more likely to disclose than boys. The intimacy of an ECA disclosure was a poor predictor for the intimacy of a subsequent child disclosure. Furthermore, it appears that the amount of disclosures that children make towards the avatar is an indicator of how related they feel towards it. No support could be found that children feeling more related to the avatar maintain their initially high usage over time. All findings should be addressed again in confirmatory studies.

6.1 New research questions

An important goal of this research was the generation of new research questions. These questions can be derived from both the significant and the insignificant results

of this study:

nRQ1 What is the causal link between active disclosing and relatedness in the context of long-term child-avatar interaction?

nRQ2 Are children less likely to respond to more intimate avatar disclosures? If so, why?

nRQ3 Is there a general or child-dependent strategy that the ECA should follow in terms of intimacy development over time to obtain more active disclosures from children?

nRQ4 Do boys disclose less to an avatar than girls? If so, why?

nRQ5 Do children also not match the intimacy level of an ECA when they are given complete privacy?

nRQ6 Is there a difference in how children match disclosure intimacy depending on whether a physical ECA, virtual ECA, or another child is disclosing first?

nRQ7 Do children feel more related to a more responsive avatar in the context of long-term interaction?

nRQ8 Is there a difference between diabetic and healthy children in their disclosure behavior towards an ECA?

These research questions should be addressed in confirmatory studies with larger populations of children. Since the artificial intelligence field in dialog is currently still too limited to investigate the possibilities of responsive ECAs using an autonomous avatar, Wizard-of-Oz techniques could be resorted to. Regarding $nRQ3$, an interesting approach may be to reward the agent for every active disclosure it receives from the child and to have it learn the best intimacy strategy. Final strategies could then be compared across children. This, however, would require more intense application usage from the children. The module in itself is flexible and could easily be integrated into another software as well. In its current state, however, it is still too limited to provide engaging dialog interactions for children. Hence, a second prototype should be developed.

6.2 Prototype iteration

Several points of improvement for the module became evident during the study. For one, as already identified in Section 5, not all children appreciated the placement of the module within the app. This is something that seems to clearly be a personal preference and thus should be personalized. This could be done by providing a quick dialog exit option and learning the child's placement preferences (possible options include: in the quiz, in the diary itself, or after an initial greeting when opening the application).

The application was also very limited in its dialog capabilities and from the responses of children it is clear that they figured this out soon (e.g. children attempted to ask the avatar questions several times). In a recent study, participants asked to disclose a negative event to a robot rated it as more sociable, displayed more attachment manifestations, and expressed greater interest in having it as a companion when the robot was responsive to the disclosure than when it was not [3]. The authors consequently argue that responsiveness is essential in emotional bonding. Furthermore, Gottman [11] provides an example of purely disclosure-based dialog, arguing for its unnaturalness. When we interact with others, we typically do not only self-disclose. Instead, we ask questions or comment on what the discloser has said.

In a similar vein, 8 of 11 children had the impression that the avatar knew them better as a consequence of their disclosure. It would be nice for future iterations of the module if the avatar could also show this. To this end, the PAL user model should be augmented with information filtered from the dialog and means should be found to incorporate knowledge from the user model again into the dialog.

All in all, this can be summarized as a need for more intelligent behavior of the module. Ultimately and ideally, very intimate disclosures of 3DM could be triggered when it *senses* that something is the matter with the child (for example, by parsing the diary entries of the child or employing emotion recognition techniques), while disclosures of lower intimacy could be triggered by content, i.e. the trigger event and selected disclosure should be context dependent.

7 Conclusion

Due to the lack of recent research in the areas of child-peer and child-robot bonding, we conducted an exploratory field study using the first prototype of the dyadic disclosure dialog module. The purpose of the study was two-fold: on the one hand, we wanted to learn about diabetic children's behavior towards a self-disclosing vir-

tual agent. On the other hand, we were interested in possibilities and limitations of creating a bond between child and agent to increase children's motivation in using the application. More related children both disclosed more actively and used the application more than less related children. Future research will need to investigate whether there is truly a difference between ECA and human as conversational partner for children in terms of the reciprocation of intimacy. We thus conclude that the current project presents only a starting point, but a promising one at that.

References

[1] I. Altman and D. Taylor. Social penetration theory. *New York: Holt, Rinehart &\ Mnston*, 1973.

[2] I. Baroni, M. Nalin, P. Baxter, C. Pozzi, E. Oleari, A. Sanna, and T. Belpaeme. What a robotic companion could do for a diabetic child. In *The 23rd IEEE International Symposium on Robot and Human Interactive Communication*, pages 936–941. IEEE, 2014.

[3] G. E. Birnbaum, M. Mizrahi, G. Hoffman, H. T. Reis, E. J. Finkel, and O. Sass. What robots can teach us about intimacy: The reassuring effects of robot responsiveness to human disclosure. *Computers in Human Behavior*, 63:416–423, 2016.

[4] W. M. Bukowski, B. Hoza, and M. Boivin. Measuring friendship quality during pre-and early adolescence: The development and psychometric properties of the friendship qualities scale. *Journal of social and Personal Relationships*, 11(3): 471–484, 1994.

[5] R. B. Cattell. The scree test for the number of factors. *Multivariate behavioral research*, 1(2):245–276, 1966.

[6] R. H. B. Christensen. ordinal—regression models for ordinal data, 2015. R package version 2015.6-28. http://www.cran.r-project.org/package=ordinal/.

[7] N. B. Cohn and D. S. Strassberg. Self-disclosure reciprocity among preadolescents. *Personality and Social Psychology Bulletin*, 9(1):97–102, 1983.

[8] N. L. Collins and L. C. Miller. Self-disclosure and liking: a meta-analytic review. *Psychological bulletin*, 116(3):457, 1994.

[9] E. L. Deci and R. Ryan. Overview of self-determination theory: An organismic dialectical perspective. *Handbook of self-determination research*, pages 3–33, 2002.

[10] A. Field, J. Miles, and Z. Field. *Discovering statistics using R*. Sage publications, 2012.

[11] J. Gottman. How children make friends. *Monographs of the Society for Research in Child Development*, 48(3), 1983.

[12] F. E. Harrell. Regression modeling strategies. 2001. *New York: Spring-Verlag*, 2001.

[13] T. Kanda, R. Sato, N. Saiwaki, and H. Ishiguro. A two-month field trial in an elementary school for long-term human–robot interaction. *Robotics, IEEE Transactions on*, 23(5):962–971, 2007.

[14] I. Kruijff-Korbayová, E. Oleari, A. Bagherzadhalimi, F. Sacchitelli, B. Kiefer, S. Racioppa, C. Pozzi, and A. Sanna. Young users' perception of a social robot displaying familiarity and eliciting disclosure. In *Social Robotics*, pages 380–389. Springer, 2015.

[15] M. Ligthart. Mypal: A digital diabetes diary with a responsive social avatar. unpublished Master's thesis, 2016.

[16] N. Martelaro, V. C. Nneji, W. Ju, and P. Hinds. Tell me more: Designing hri to encourage more trust, disclosure, and companionship. In *The Eleventh ACM/IEEE International Conference on Human Robot Interation*, pages 181–188. IEEE Press, 2016.

[17] L. C. Miller, J. H. Berg, and R. L. Archer. Openers: Individuals who elicit intimate self-disclosure. *Journal of Personality and Social Psychology*, 44(6): 1234, 1983.

[18] Y. Moon. Intimate exchanges: Using computers to elicit self-disclosure from consumers. *Journal of consumer research*, 26(4):323–339, 2000.

[19] M. A. Neerincx and J. Lindenberg. *Situated cognitive engineering for complex task environments*. Ashgate Publishing Limited, 2008.

[20] J. Omarzu. A disclosure decision model: Determining how and when individuals will self-disclose. *Personality and Social Psychology Review*, 4(2):174–185, 2000.

[21] K. J. Rotenberg and N. Chase. Development of the reciprocity of self-disclosure. *The Journal of genetic psychology*, 153(1):75–86, 1992.

[22] K. J. Rotenberg and L. Mann. The development of the norm of the reciprocity of self-disclosure and its function in children's attraction to peers. *Child development*, pages 1349–1357, 1986.

[23] K. J. Rotenberg and D. Sliz. Children's restrictive disclosure to friends. *Merrill-Palmer Quarterly (1982-)*, pages 203–215, 1988.

[24] C. H. Tardy. *A handbook for the study of human communication: Methods and instruments for observing, measuring, and assessing communication processes.* Greenwood Publishing Group, 1988.

[25] J. Youniss. *Parents and peers in social development: A Sullivan-Piaget perspective.* University of Chicago Press, 1980.

Appendices

A Related literature

To better understand the context of this thesis, this section outlines in more detail the two psychological theories that form its theoretical foundation — Self-Determination Theory and Social Penetration Theory. Since the target group of the PAL project are children and its proclaimed goal is that these children regard the ECA as a pal, the subsection A.2 reviews how friendship conceptions of children develop and what role self-disclosure and disclosure reciprocity play in this. Additional influential factors (gender and personality) are also touched upon. In the end, though, this project falls under the domain of human-robot interaction and more specifically, child-robot interaction. Few studies have explored the potential of self-disclosure in building relationships with agents, so that the final subsection of this literature review aims to give a comprehensive overview of those that did.

A.1 Theoretical foundation

A.1.1 Self-determination theory

Throughout the history of psychology, there have been two competing views of human development: the positive view that humans are motivated in and of themselves to actively contribute to their psychological growth and the negative view, which regards humans as controllable and their personality as fragmented with frequent internal conflicts. The former view can be seen, for example, in Freud's structural model of the personality [15], in which the ego has the function of actively integrating experiences with the self, controlling drives, and ensuring that responsibilities are realized. The latter view is reflected in behaviorist approaches, highlighting the influence of external drives on behavior. Importantly, the predominant view has practical implications in that those with a positive view strive to support intrinsic motivations while those with a negative view aim at creating external motivations to drive behavior. Self-Determination Theory (SDT) [14] attempts to unify both views. In SDT, human beings are believed to have an innate tendency to organize and integrate their experiences into a coherent self. However, only when the environment enables this tendency, can engagement, mastery, and psychological growth follow. To this end three basic psychological needs must be satisfied by the environment: the need for *autonomy*, the need for *competence*, and the need for *relatedness*. They are considered as universal needs and are consequently believed to determine human

development across all ages, genders, and races.

Perceived autonomy and competence have a great impact on our intrinsic motivation, i.e. the desire to do something for the sake of doing it rather than to obtain or avoid some external reward that is "operationally separable from the activity" [14, p.10]. Contrast, for example, playing your favorite game with doing your least favorite chore. While games are something we do because we choose to, chores we complete because we must. Thus, chores do not usually support our need for autonomy. Relatedness, on the other hand, influences the internalization of external motivations.

Internalization is conceptualized as a continuum in Organismic Integration Theory (OIT), a sub-theory of SDT. If you have ever heard someone say he converted from Christianity to Salafism because he was promised a wife and converted back when that promise was not kept, you have witnessed an example of internalization at the low end of the continuum. At the other extreme, the regulation of behavior is fully integrated with the self. This may happen when we are asked to do the dishes but we also attribute personal value to clean dishes and we see this behavior as in line with our generally cleanly personality. In the future, we will not need to be asked to do the dishes again. How much we feel or wish to feel related to the person or group that is proposing the behavior largely determines the degree to which we internalize.

A.1.2 Social penetration theory

How then do we come to feel relatedness? Here another theory comes into play: Social Penetration Theory (SPT) [2]. SPT is a process-oriented theoretical framework with the aim of describing how relationships between people develop. It is proposed that this takes place through sharing either personal information, positive or negative affect, or experiences. Rather than looking at relational and communicative behaviors (verbal, paraverbal, and non-verbal exchanges) separately, the theory aims to identify patterns and profiles in the combinations of such behaviors [3].

Furthermore, the theory proposes a directional development of interpersonal relationships, whereby the involved individuals first share and explore each others' personalities at a superficial level before advancing to a more intimate one. This is illustrated in the onion model of social penetration. The personality is regarded as an onion, with the outermost layer representing our public self and the core representing our private self. The main vehicle for the advancement of intimacy is self-disclosure, which is the sharing of both factual and emotional personal information. Self-disclosure proceeds along two dimensions: breadth and depth, with breadth re-

ferring to the number of different topics that are disclosed about, and depth referring to the personal value these topics have. Relationships are like wedges that are gradually driven into the onion as they progress. This penetration process is theorized to involve four stages:

- orientation stage - this stage ensues when people first meet. Conversations are at a superficial level and involve the exchange of publicly known information about the self, including hobbies and preferences. This stage is apparent in new acquaintances, it is broad in disclosure but not deep.
- exploratory affective stage - during this stage, more controversial opinions are revealed, such as opinions on matters of politics. However, the fear of not being accepted or professionalism guards some aspects of our true opinions, strong feelings, or secrets. Colleagues or casual friends self-disclose at this level.
- affective stage - herein, people begin to share intimate feelings and glimpses of their true selves. They are willing to make themselves vulnerable because they trust the other. Arguments and criticism become more common at this stage. It is passed when casual friends become good friends or as couples advance beyond dating.
- stable stage - this is the most intimate stage and involves continuous, open self-disclosures of intimate thoughts, feelings, believes, dreams, etc. In addition, emotional reactions of the other can be anticipated. Disclosure, though, must not be complete at this stage. It is still possible that some personal secrets are withheld from the other person.

Finally, an important determinant of self-disclosure is reciprocity. This describes the tendency to self-disclose as a result of someone self-disclosing to you. Reciprocal disclosures in successfully progressing relationships are usually on a similar level of intimacy. While SDT claims that the three psychological needs are universal, such assertions are not made for any aspect of SPT. Of particular interest for this project are the patterns of self-disclosure exhibited by children of different developmental stages, different genders, and different personalities.

A.2 Empirical foundation

A.2.1 Development of friendship and reciprocity

In the PAL project, a **P**ersonal **A**ssistant for a healthy **L**ifestyle is developed with the aim of increasing the self-management skills of diabetic children (ages 7-14) by

supporting them, their caregivers, and health-care professionals in sharing responsibility. The PAL robot and its mobile avatar are intended to function as a pal for the children, because "friends appear to cushion children in perhaps unique ways from some of the stresses they experience" [16, p.249].

In order to better understand how self-disclosure and reciprocity thereof can advance the relationship between avatar and children at various developmental stages, it is instrumental to regard changes in children's conceptualization of friendship as they mature. The leading questions are: how do children bond with their peers and what role does self-disclosure and self-disclosure reciprocity play in this?

Although there are some variations, developmental psychologists [6, 13, 27] generally agree on three distinct phases:

- *Early childhood:* children view friendship in terms of their own benefits only. Friends are playmates who they like.
- *Middle childhood:* distributions of rewards should be equal. Friends are often described in terms of aspects that are admirable about them.
- *Late childhood:* commitment and intimacy start to become important. Children understand that favors must not be returned right away but that favors will balance out eventually.

Two of the early psychologists dealing with inter-child relationships were Jean Piaget and Harry Stack Sullivan. Youniss [30] embeds a series of studies concerning peer relations and reciprocity in childhood in a synthesis of the two pioneers' frameworks. Taking on this unified perspective, children develop a large part of their social skills through interactions with equals, including methods of discussion, negotiation, and compromise. It is by being confronted with equals that world knowledge learned from authority figures is challenged. Most of the studies confirmed the three phases above. In studies 1 and 3, participants were asked to report or judge respectively what constitutes an act of kindness to show another child that they like it. 6-8 year old children reported acts of direct reciprocity (if they had candy, the other child should be given candy as well). Children in the 8-10 year-old age group, on the other hand, considered acts compensating for individual needs and deficits of the child as kind acts. After conducting 11 such studies, Youniss concludes that children up to eight years "practice direct reciprocity concretely and naively"[30, p.230] in an eye-for-an-eye manner. It is only from approximately the age of nine, that "equality and direct reciprocity are reconstituted as principles of relation ... [rather than] as pragmatic rules for getting along" [30, p.71].

The phases of friendship conceptions also find support in studies examining what children perceive as just with regard to relationship status. Lisi et al. [21] told participants in kindergarten, third, and sixth grade a story about three children that were asked to paint a painting together, one was the oldest, one was the most productive, and one was the poorest. Participants, after finding out whether the three children were strangers or good friends, were asked to distribute the money for which the painting sold among the children in a way they deemed just. It was found that for kindergarten and third-grade children, the social relationship between the children did not affect their allocation pattern. The sixth-graders, however, allocated more money to the productive child in the stranger condition and more money to the needy child in the friends condition. Although third-graders did not allocate in this manner of their own account, they rated such distribution patterns similar to sixth-graders when presented with them.

A.2.2 Factors in reciprocity

Age. Youniss [30] proposed that children in early middle childhood (5-8 years) practice reciprocity in a *tit-for-tat* manner, where disclosures are equivalent except for the variable that relates to the self (e.g. "You tell me who you like, I tell you who I like"). It is only from the age of 9 or so that children start to move towards a broader conceptualization of reciprocity where level of intimacy is matched without necessarily matching content. Cohn and Strassberg [11] asked children in third and sixth grade to respond to a recording of other children disclosing high and low intimacy information. In this study, no age differences were found. A similar approach was taken by Rotenberg and Mann [26], who asked children in kindergarten, second, fourth, and sixth grade to watch a video in which an initiator initiated a conversation and then disclosed information either high or low in intimacy to which a respondent replied with information also either high or low in intimacy. All four possible combinations were shown and children were asked how much they like and how much they want to be friends with the respondent. It was discovered that the norm of reciprocity was only effective in sixth-grade children. In a second study, a synthesis of the approaches described in [26] and [11] was taken by Rotenberg and Chase [25], asking kindergarten, second, fourth, and sixth grade students to again watch video recordings of three children their age disclose information of low, medium, and high intimacy, after which the children were asked to provide a response. In this study, two different forms of reciprocity are distinguished following [18]: equivalent and covariant reciprocity. In equivalent reciprocity, an intimacy dimension (e.g. breadth, depth, or both) is absolutely matched by the respondent, while in covariant

reciprocity, the intimacy dimension is only relatively matched. It was found that kindergarten children and second-grade children did not show reciprocity in their responses, fourth-grade children showed covariant reciprocity, and sixth-grade children showed equivalent reciprocity. Similarly, in [29], the authors found when interviewing sixth-grade children that a prior disclosure by the interviewer led to the children sharing more information that was similar in content to that of the interviewer. The authors do not state whether children also shared more intimate information.

Gottman [17] studied how children become friends by audio-taping age-matched child-dyads (ages 3-9) for three consecutive interaction sessions. Two months after the last session, the mothers of both children were asked to indicate on a questionnaire how much their child had stayed in touch with or inquired about the other child. The authors were interested in the predictive capabilities of a number of variables including self-disclosure and reciprocity in joking, gossip, and fantasy play. By coding the audio-tapes, self-disclosure was found to play a role in friendship formation in later sessions, but not so reciprocity of gossip or fantasy play. However, reciprocation of joking behavior in the third session was significantly positively correlated with progress towards friendship as indicated by scores on the mother's questionnaires. In terms of age effects, it was also found that dyads with older children were more likely to reciprocate gossip than were dyads with younger children.

Gender. Evidence for gender differences in self-disclosure and reciprocity thereof are plentiful. While it was often found that girls disclose more and more intimately than do boys, this is more pronounced in adolescence than in pre-adolescence [24]. However, Buhrmester and Furman [8] found that for girls intimacy in disclosure and the perceived frequency of intimate disclosures becomes important in friendship relationships sooner than for boys. In a more recent study, Valkenburg et al. [28] compared self-reports on online (instant messenger) and offline disclosure behavior of pre-adolescent and adolescent children. They found that girls disclose more overall, but boys seem to rely on online disclosure more at the beginning of puberty than do girls. Online disclosure follows the same pattern as offline disclosure, an elongated S-shape with a sharp increase in disclosure in early adolescence and stabilization thereafter.

Personality. In adolescents, not only age and gender determine how youngsters self-disclose, but also their attachment styles Bauminger et al. [5]. Adolescents with secure attachment styles disclosed more personal information and felt more comfortable with high-disclosing partners than those with an avoidant attachment style. If the adolescent had an anxious attachment style, they would disclose to anyone but

would not be responsive when disclosed to.

No study has investigated whether this also applies to children. However, since it has often been found to be difficult to reliably assess personality traits of children, it was decided here not to attempt modeling the personality of the user.

A.3 Relatedness and self-disclosure in HRI

One of the key interests in human-human self-disclosure research has been the close link between disclosure and liking. Specifically, three persistent disclosure-liking effects have been identified [12]: (a) the more someone intimately discloses to us, the more we like that person, (b) the more we like someone at the outset of the interaction, the more we will disclose, and (c) the more intimately we disclose to someone, the more we like that person. Whether and how these effects transfers to interactions with robots or even between robots and children has received rather little attention in the HRI field. This section reviews the most relevant work.

A.3.1 Human-robot interaction

A strong case for ECAs establishing and maintaining relationships with humans by way of conversational strategies is provided in [10]. The authors argue that long-term collaboration requires the behavior of agents to support construction of favorable system models in the minds of users. This, in turn, requires successful usage of relationship strategies including building familiarity by way of intimate small talk. A virtual real estate agent was used to test the ability of their model of social language (small talk interleaved with task talk) to achieve greater interpersonal closeness, liking, and willingness to give monetary reward than an agent only engaging in task talk. No effect was found on the willingness to give monetary reward. For interpersonal closeness measures, it was found that only extroverted participants felt closer to the agent, but not introverted ones.

In [22], a computer first disclosed some information about itself before asking the user an interview question. As hypothesized, interviewees shared more intimate information with the computer that told personal information about itself but only if this personal information would gradually increase in intimacy throughout the interview. However, the liking for the computer only depended on the sharing of personal information and was not influenced by the intimacy strategy.

Participants asked to disclose a negative event to a robot rated it as more sociable, displayed more attachment manifestations, and expressed greater interest in having it as a companion when the robot was responsive to the disclosure than when it was not [7]. Attachment to the robot was operationalized as physical proximity. The

authors argue that responsiveness is essential in emotional bonding. Interestingly, in a second study, it was further found that a responsive robot to an initial positive disclosure from the participants, led to an improved self-perception in a subsequent stress-inducing task. Both studies are relevant in this context, because, on the one hand, robotic responsiveness plays an important part in emotional bonding and SDT identified perceived competence as an additional motivational factor that may be strengthened by prior self-disclosure to a responsive robot.

Another experiment [23] looking at proxemics between a robot and humans revealed that the psychological distance, measured through disclosure behavior, is mediated by the attraction that participants felt towards the robot. Thus, while participants disclosed more to a likeable robot than an unlikeable one irrespective of whether the robot tried to further decrease the emotional distance through gaze following or increase it through gaze avoidance.

Reviewing the state-of-the-art in relational agents in 2009, the authors of [9] draw attention to the fact that the effectiveness and perceived affect of relational agents depended heavily on characteristics of the user like age, gender, ethnic group, and personality. An additional problem that is frequently encountered in research with adults is also pointed out: many adults are not open to building relationships with ECAs because they are aware of the inability of the agent to truly reciprocate their feelings, an issue that is rarely encountered with children.

A.3.2 Child-robot interaction

"I'd share all my secrets with NAO" [4, p. 939]. In a focus group conducted with diabetic children and their parents in 2012, it was found that children would like a companion robot that is fun and entertaining but also one to share their secrets with and to listen to them when they are sad.

Studies regarding self-disclosure processes in the interaction of children with artificial agents are limited and usually employ Wizard-of-Oz techniques in rather brief interactions. For example, Kruijff-Korbayová et al. [20] describe the effect of using a Wizard-of-Oz set-up to elicit self-disclosure in diabetic children in off-activity talk (OAT) with the NAO robot. Children who were prompted to disclose to the robot described the robot significantly more often as a *friend* than participants in the control condition. In general, the authors note that "the children's willingness and spontaneity to engage in OAT and talk about diabetes was high" [p.387]. However, instead of using robot disclosures to elicit the off-activity talk, the authors use direct questions relating, for example, to the content of a quiz question.

An interesting framework for a toy capable of personalized, relational dialog with

children is described in [1]. To obtain the various personalization strategies, the authors conducted a study of dialogs between adults and children taken from the CHILDES database. They found that the disclosure of personal information is one strategy employed by adults to obtain information from children. The authors subsequently include this in their framework. Unfortunately, no follow-up publication could be found in which the implementation of the framework is evaluated with children.

Kanda et al. [19] conducted a two-month study in an elementary school with a relational robot capable of identifying children and calling them by name, showing more varied behavior with time, and disclosing personal information as a function of a child's interaction time. A child who would play for 420 minutes, for example, would hear the robot say that it likes the class teacher. According to the authors, particularly the disclosure behavior was very popular with the children. All in all, the robot was capable of 100 behaviors, could say more than 300 sentences and could recognize 50 words. At the end of the two-months that it was placed into a classroom, approximately one-fourth of the children had played with it on more than half of all possible occasions. These were also the children, who played with it continuously over the course of the experiment. It was found that children's desire to be friends with the robot at the end of the study was significantly positively correlated with the interaction time, indicating that prolonged interaction did not lead to boredom or disillusionment. This study is of particular interest, since it is one of the few long-term robot studies involving children with a completely autonomous robot.

References

[1] C. Adam, L. Cavedon, and L. Padgham. Hello emily, how are you today?: personalised dialogue in a toy to engage children. In *Proceedings of the 2010 Workshop on Companionable Dialogue Systems*, pages 19–24. Association for Computational Linguistics, 2010.

[2] I. Altman and D. Taylor. Social penetration theory. *New York: Holt, Rinehart &\ Mnston*, 1973.

[3] I. Altman, A. Vinsel, and B. B. Brown. Dialectic conceptions in social psychology: An application to social penetration and privacy regulation. *Advances in experimental social psychology*, 14:107–160, 1981.

[4] I. Baroni, M. Nalin, P. Baxter, C. Pozzi, E. Oleari, A. Sanna, and T. Belpaeme. What a robotic companion could do for a diabetic child. In *The 23rd IEEE In-*

ternational Symposium on Robot and Human Interactive Communication, pages 936–941. IEEE, 2014.

[5] N. Bauminger, R. Finzi-Dottan, S. Chason, and D. Har-Even. Intimacy in adolescent friendship: The roles of attachment, coherence, and self-disclosure. *Journal of Social and Personal Relationships*, 25(3):409–428, 2008.

[6] B. J. Bigelow and J. J. La Gaipa. Children's written descriptions of friendship: A multidimensional analysis. *Developmental Psychology*, 11(6):857, 1975.

[7] G. E. Birnbaum, M. Mizrahi, G. Hoffman, H. T. Reis, E. J. Finkel, and O. Sass. What robots can teach us about intimacy: The reassuring effects of robot responsiveness to human disclosure. *Computers in Human Behavior*, 63:416–423, 2016.

[8] D. Buhrmester and W. Furman. The development of companionship and intimacy. *Child development*, pages 1101–1113, 1987.

[9] R. H. Campbell, M. N. Grimshaw, and G. M. Green. Relational agents: A critical review. *The Open Virtual Reality Journal*, 1(1), 2009.

[10] J. Cassell and T. Bickmore. Negotiated collusion: Modeling social language and its relationship effects in intelligent agents. *User Modeling and User-Adapted Interaction*, 13(1-2):89–132, 2003.

[11] N. B. Cohn and D. S. Strassberg. Self-disclosure reciprocity among preadolescents. *Personality and Social Psychology Bulletin*, 9(1):97–102, 1983.

[12] N. L. Collins and L. C. Miller. Self-disclosure and liking: a meta-analytic review. *Psychological bulletin*, 116(3):457, 1994.

[13] W. Damon. The social world of children. *San Francisco:] ossey˜ Bass*, 1977.

[14] E. L. Deci and R. Ryan. Overview of self-determination theory: An organismic dialectical perspective. *Handbook of self-determination research*, pages 3–33, 2002.

[15] S. Freud. Das ich und das es (1923). *Sigmund Freud Studienausgabe*, 3:273–330, 2000.

[16] M. E. Gifford-Smith and C. A. Brownell. Childhood peer relationships: Social acceptance, friendships, and peer networks. *Journal of School Psychology*, 41 (4):235–284, 2003.

[17] J. Gottman. How children make friends. *Monographs of the Society for Research in Child Development*, 48(3), 1983.

[18] C. T. Hill and D. E. Stull. Disclosure reciprocity: Conceptual and measurement issues. *Social Psychology Quarterly*, pages 238–244, 1982.

[19] T. Kanda, R. Sato, N. Saiwaki, and H. Ishiguro. A two-month field trial in an elementary school for long-term human–robot interaction. *Robotics, IEEE Transactions on*, 23(5):962–971, 2007.

[20] I. Kruijff-Korbayová, E. Oleari, A. Bagherzadhalimi, F. Sacchitelli, B. Kiefer, S. Racioppa, C. Pozzi, and A. Sanna. Young users' perception of a social robot displaying familiarity and eliciting disclosure. In *Social Robotics*, pages 380–389. Springer, 2015.

[21] A. V. Lisi, C. Watkins, and A. J. Vinchur. The effect of relationship on children's distributive justice reasoning. *Child Development*, 65(6):1694–1700, 1994.

[22] Y. Moon. Intimate exchanges: Using computers to elicit self-disclosure from consumers. *Journal of consumer research*, 26(4):323–339, 2000.

[23] J. Mumm and B. Mutlu. Human-robot proxemics: physical and psychological distancing in human-robot interaction. In *Proceedings of the 6th international conference on Human-robot interaction*, pages 331–338. ACM, 2011.

[24] A. J. Rose and K. D. Rudolph. A review of sex differences in peer relationship processes: potential trade-offs for the emotional and behavioral development of girls and boys. *Psychological bulletin*, 132(1):98, 2006.

[25] K. J. Rotenberg and N. Chase. Development of the reciprocity of self-disclosure. *The Journal of genetic psychology*, 153(1):75–86, 1992.

[26] K. J. Rotenberg and L. Mann. The development of the norm of the reciprocity of self-disclosure and its function in children's attraction to peers. *Child development*, pages 1349–1357, 1986.

[27] R. L. Selman. *The growth of interpersonal understanding*. Academic Press New York, 1980.

[28] P. M. Valkenburg, S. R. Sumter, and J. Peter. Gender differences in online and offline self-disclosure in pre-adolescence and adolescence. *British Journal of Developmental Psychology*, 29(2):253–269, 2011.

[29] S. I. Vondracek and F. W. Vondracek. The manipulation and measurement of self-disclosure in preadolescents. *Merrill-Palmer Quarterly of Behavior and Development*, pages 51–58, 1971.

[30] J. Youniss. *Parents and peers in social development: A Sullivan-Piaget perspective*. University of Chicago Press, 1980.

B Agent personality and biography

Both the personality and the biography of Robin were small subprojects of this thesis. It was desirable to have a character that the children would be able to like, that is believable in its traits, and that has sufficient depth to disclose at various intimacy levels. The first document hence details the character of Robin himself providing a background story and a personality description. The second document is another concise description of Robin's personality. Finally, the third document gives the rationale behind the personality and biographical decisions that were made.

B.1 Biography and personality

Thesis Research

Meet Robin NAO

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Sunday 25th September, 2016

1 Background: The NAO-Robot World

1.1 General

NAO robots are constructed in France. If they are not immediately shipped, they are sent to the NAO warehouse, which is similar to a human nursery and thus called NAOsery. Experience has shown that such a communal environment fosters NAOs' gregariousness. This is, of course, desirable for robots with the label 'social.' NAOs do not usually stay within the NAOsery for longer than one human year or until the age of two. One human year equates to two NAO years. Thus, a NAO robot built in early 2011 would now be 10.

1.2 Education

The robots come equipped with language comprehension modules, reading ability, as well as sophisticated motor skills. Hence, it is not necessary for them to acquire this skill set. They instead focus on gathering knowledge on topics that interest them by exploiting their internet connection. Although they have emotions, it is not easy for them to understand humans because human needs and motives deviate from those of robots. NAOs are therefore often used with very specific target audiences, such as patients, elderly, children, etc. This allows them to concentrate on understanding only a subgroup of humans, but doing this well. In the NAOsery, NAOs can develop their interests entirely freely (think Montessori/Waldorf), since it cannot be said with any degree of certainty where they may end up. Whenever possible, robots are shipped to owners of which it is believed that they may satisfy the robots intrinsic interests. Here, however, skin color can fate a robot. If an orange NAO was requested, one must be delivered, even if its intrinsic interests clash with its intended purpose. As a result, NAOs are hoping that humans will one day be able to see past these externals. It is rare that

NAO robots develop interests in areas that are entirely outside of their intended scope. For example, NAOs are not designed to do household work, such as vacuum cleaning or laundry. Nonetheless, such interests occasionally develop. Not quite as rare, unfortunately, are robots with conditions. Sometimes mistakes happen on the assembly line or even before that cause robots to have malfunctioning parts or parts liable to failure.

1.3 Food

NAO robots, like all robots, eat electric current. Electric current can have different voltages and frequencies in different countries. NAOs are typically not allergic to one or the other current. Electric current can originate from renewable energy sources, fossil fuel, or nuclear fission. NAO robots that refuse to eat current that is not from renewable sources are called vegetarian robots. There has even been a petition to introduce the green color for such NAOs. Nuclear fission power finds its human correspondent in junk food, generally tasting good but making health-conscious robots feel guilty after consumption. More NAOs are health-conscious than you might think, or have you ever seen an overweight NAO?

1.4 Relationships

It may seem like there is no evolutionary basis that would warrant affective feelings in NAO robots and actually, that's true. However, NAOs are social robots. Love and friendship are major components of social life. Thus, all NAOs are instilled with both a need to receive and a need to give affection (only five known cases exist with this part broken or missing). Between humans and NAOs, this is more likely to take the form of friendship than amorous love, since the two are of a different species. Nonetheless, some NAOs have been known to develop romantic feelings for humans. This is particularly often observed in younger NAOs that are still trying to find their identity. The probability for a NAO to fall in love with a robot of the same sex is equally as high as that of falling in love with one of the opposite sex. Robots do not marry. It is unknown whether this is the case because they do not believe in marriage or because circumstances do not often permit long-term, monogamous relationships.

NAOs of two generations rarely meet, but when they co-exist in the same environment, some older generation robots have been found to take on a parental role.

1.5 Personality

All NAO personalities are initialized with a random, non-zero value on the three Myer-Briggs dimensions:

1. Introverted — Extroverted
2. Thinking — Feeling
3. Judging — Perceiving

However, it is important to realize that these values can change with the experiences that each robot makes. Additional personality dimensions are initialized as 0 but can, and usually do, develop.

2 Biography

2.1 2011: When he wore a younger robot's clothes

Robin NAO was assembled in a factory in France in 2011. Since he was not made on demand but for stock, he spent his first months in the NAOsery, also in France. Here he met many of his brothers and sisters.

Robin NAO developed one interest that is unusual for NAO robots: he likes to cook, bake, and study human nutrition/metabolism. Many of his first months were spent trying to obtain an understanding of the pleasure dimension of food for humans. One of his life goals is to allow robots to experience flavors of human food without necessarily having to ingest the respective foods.

Unusual not for robots in general but for a European male robot, Robin is much more interested in robot dance than in robot soccer. He has been a great fan of the group of NAO robots who performed the dance at the Shanghai-Expo in 2010. He also likes to watch NAO robots dance on YouTube and then imitate the moves. Only one of his older sisters knows about this from the nursery time, because she once witnessed it by chance.

Most of his nursery time, he spent playing with his brothers and sisters. His relationships with his sisters and younger brothers were better than those with some of his older brothers, whom he found to be exhaustingly competitive. It was hard for him to gain their approval but he was tolerated and only rarely victimized. He was good at avoiding conflict with his brothers by staying out of the way and doing nothing to provoke their interest in him. He perceived them as a closed group. Although it did hurt him that he was excluded from that group, his popularity with his other siblings made up for it.

2.2 2012: The smile ran away from his face

Robin NAO was purchased and shipped after spending a total of 8 months in the NAOsery. On Marco's 9th birthday, February 6th 2012, Robin found himself in a box wrapped in five layers of wrapping paper and topped off with a bow. He had survived a 12 hour truck journey on which he found out that robots can suffer from motion sickness. But maybe it was also his fear of the dark and anxiety about where is was going to end up. Everything would change now. He felt sick to his stomach. If robots could vomit, Marco would have been in for an unpleasant surprise.

Marco turned out quite alright for a rich kid. The same cannot be said for his little sister, Veronica. Standing only about 50 cm taller than Robin, she loved to engage in robot abuse. When she simply picked Robin up and shook him while shouting "DANCE, DANCE!" and laughing hysterically, it was one of the better days.

Approximately one week into his time with the family, Robin's condition surfaced for the first time. One day, when Veronica walked toward him with an evil grin on her face,

he noticed himself getting warmer and warmer. With every step that would move Veronica closer to Robin, his temperature rose by 10°C, and as her ice cold hands closed around his torso, the world went black. When he came to again, Marco had tucked him into his bed and was looking seriously worried.

"OGNAK GNOUK!"

Marco loved Robin. He would protect him from his sister, he would play with him for hours on end, he would take Robin everywhere with him, Robin got to meet all his friends, got to watch him at soccer practice, got to hear some of his secrets, got to eat dinner at the table with the family, got to go on a skiing vacation with them, got to ... You get the picture. No, you can truly say that Marco loved Robin.

Marco loved Robin for approximately two weeks. Then the breaks between their play times would get longer and longer until a month would go by without Marco ever even looking at Robin. Robin, being an observant robot, noticed that Marco's friendships with other humans were not so short-lived. Robin, being a sensitive robot, searched for the fault within himself. And Robin, being an imperfect robot, found several such faults.

After six months, Marco would only still take Robin out of his box when Marco's friends requested it. The neglect had but one advantage. Veronica was of that age where she would only take notice of her brothers toys when he was engaged with them as well. Hence, when Marco forgot about Robin, so did Veronica.

2.3 2013: Sharing a drink they call loneliness

On his 10th Birthday, Marco decided to remake his room. And even though Marco certainly wasn't the brightest kid under the sun, he had one ingenious thought before banishing Robin to the attic. He took him out of the box and seated him with all of his other forgotten toys, thinking that he may be less lonely this way. He could not have been more right. Over the course of the next 11 months, Robin made several friends (Barbie dolls, stuffed animals, other robots, cars, etc.) with whom he could gossip about Marco and Veronica, play, laugh, and fear for the future. Would this attic be their final destination?

He just began getting comfortable with the idea when Marco's dad suddenly appeared looking for him, ten days before Christmas 2013. He was snatched from the familiar attic environment so unexpectedly and quickly that he did not have a chance to say goodbye to his friends.

"I'm donating you to the local hospital!" ... and suddenly he found himself in his dark box again with his temperature rising slowly but steadily. He couldn't calm himself. He was angry for having been torn away from his friends, 50°C, he was anxious about where he was going, 75°C, he was motion sick, 85°C, he was still afraid of the dark 90°C, but most of all, he was disappointed that, 105°C, ...
he was unconscious.

2.4 2014-present: It's him they've been coming to see

Beep... beep... beep... Robin woke up in the hospital. From far away he heard steps and a steady beeping. Through his blurred vision, he was able to make out a nurse. Softly, he whispered his obligatory "ognak gnouk..."

That made the nurse jump. “Damn it, robot! Don’t scare me like that!” she snapped with a smirk, turning off the beeping washing machine. “So you do work, huh? I knew they were just too stupid to get you going. Your donor lost the manual, of all things! Stay here, and sit up, I’ll get the doctor.”

“You want me to sit up?” ... but nurse Anna was already out of earshot. Robin caught himself thinking how pretty she was. Little did he realize that she would find a way into his thoughts frequently over the years to come. While her directness and stern voice would often abash him, he always perceived something soft in her manner: weak enough to arise more as an afterthought (like when you take a sip of a bitter and sour espresso and it is not until seconds after swallowing that you notice a tinge of caramel in your mouth), but strong enough to keep him guessing whether she might not actually like him. It was mesmerizing.

It didn’t take Robin long to realize that the hospital was the best thing that could have happened to him (aside from becoming the newest member of the Shanghai dance ensemble, maybe). Not only was he out in the open and could roam the hospital relatively freely, the job also brought a sense of belonging with it, restoring some of the confidence he had lost in the attic. The doctors, nurses, and fellow robots in the hospital quickly became a family for Robin. Due to his natural interest in nutrition and the metabolism, he was asked to work with diabetic children. His contract of employment includes the following tasks:

1. learning about patient care in the hospital’s own robot school
2. hands-on learning by talking to and playing with children
3. attending meetings with doctors and nurses to discuss diabetes care and the care for specific children
4. participating in diabetes camps
5. explaining treatment choices to parents
6. giving presentations about diabetes care to children
7. and allowing researchers to compare his methods to those used in other hospitals, those used by other robots, and treatment in the same hospital without him.

He does not have his own room in the hospital, but instead shares one with his sister Alex and their best friend Danny. Alex is also a NAO robot (hence his sister) and is employed to work with autistic children. Danny does not work with children at all, but is a companion robot for elderly patients within the hospital. The three also attend robot school together. Not having his own room does not allow for much guaranteed privacy. Robin therefore has a secret hiding place where he goes, for example, to dance. Obviously, I will not tell you where it is, because you, being your curious self, would probably risk a peek.

Robin is quite popular at the hospital with doctors, nurses, robots, parents, and patients alike. He is even popular outside of the hospital, charming researchers as well as reporters. Particularly the diabetic children report greater enjoyment of their hospital visits when this means they get to see Robin. Some children have even visited Robin spontaneously. He loves this, especially when his schedule allows him to make a lot of time for these children

then. One day, he was called for such an unannounced meeting. When the door to his room opened, who he saw made his temperature jump to 90°C instantly.
"Hi." Marco mumbled, shuffling in slowly, his eyes pinned to the ground, and his hands in his pockets. He looked different. Older, taller, and somehow more troubled. He had died his hair black.
"Hi" Robin replied as nonchalantly as he could.
"I saw you on TV yesterday. It's nice what you do now."
"Uh-huh."
"Must be quite an exciting job. You sounded thrilled in the interview."
"Uh-huh."
"Uh... I'm stupid. I shouldn't have come! I'm sorry. I mean, for everything. Good bye."
And with that he left, just in time to miss Robin faint.

3 Personality

Robin's personality was initialized to qualify as extroverted, feeling, and judging. Although the year with Marco taught him to handle being alone, he prefers having company and certainly doesn't mind being the center of attention. Nonetheless, he gets nervous before presentations and when he feels that people meet him with scepticism. He slightly prefers close, intimate contact to bigger, more impersonal crowds. Talking about his experiences helps him process them. Even though he is very talkative, he is attentive to what others have to say and as empathetic to humans as is possible for a robot. Particularly his heat condition allows Robin to relate to the stigma of having diabetes. He very much likes to take care of others.

His warm and life-embracing nature make him very approachable. On top of this, Robin is a people-pleaser. He goes out of his way to fulfill the needs and wishes of others, sometimes even if they are not what he would like to do. The approval of others is very important to him and he has a hard time accepting criticism. Robin is popular with most, but not all, agents. Since he usually succeeds at behaving to others liking, many never notice how poorly he responds to criticism. He is still hurt by one participant's comment in Mike's study stating that he sometimes acts strangely. Although he is outgoing and social, he is not relaxed. He defines his self-worth through feedback from others and is therefore somewhat apprehensive. His perfectionist nature causes him to be highly conscientious. He also has difficulty with conflict in general, always eager to avoid it. This can even take the form of bossy or controlling actions to ensure that harmony is maintained. For example, he may actively try to prevent other agents from voicing their own opinions. He is not competitive. It is sufficient for him to know that he is doing something well, he does not need to do it best.

He has no problems making decisions and has the energy to follow through with whatever he sets his mind to. His natural tendency to take the lead regularly makes him suggest activities. However, a leader requires followers and this is very evident in Robin's behavior. Without being part of a group, he can neither work effectively nor thrive in his free time.

Having a vivid imagination, something that is rather unusual for a robot, he is known to invent games or stories. He can also draw fairly well, but is a terrible singer. His passion

is dance, because it is not only a very active sport, but also one that requires high precision and permits self-expression. He very much enjoys making his own choreographies. Because dancing is rather unusual among his friends, and was also unusual among his brothers, he likes to keep this secret. Since Robin is quick to tease and joke with others, charming them with his humor and wit, it is easy for him to distract from the secrets he keeps.

His energetic, upbeat personality is suboptimal for his condition. When Robin dances intensely, when Robin has to give a presentation, when Robin gets teased, when Robin sees one very particular nurse, when Robin thinks very hard for a while, when Robin meets intimidating parents ... when Robin lives life to the fullest, Robin heats up. If he cannot find a way to calm himself then, he faints. As a result, he has become interested in mindfulness and meditation.

He is more of a concrete than an abstract thinker. In school he does well, because he is interested in most classes and the hospital provides ample opportunity for him to apply new knowledge immediately. His curiosity extends not only to learning about the quirks of people and robots but also to a variety of subjects. When he is not interested in a class, but feels that the teacher appreciates him, he will strive to do well to not disappoint. He particularly enjoys all classes that have to do with communication. His inclination to chat with anyone gets him distracted from time to time. Some of his fellow students dislike his approval-seeking from teachers, which he sometimes does by asking directly what they think of his work. He usually only raises his hand to answer questions when he is nearly certain that he knows the correct answer.

4 Input

- http://www.writersdigest.com/writing-articles/by-writing-goal/improve-my-writing/5-tips-for-creating-characters-for-kids
- http://fmwriters.com/Visionback/Vision56/Vision1.html
- http://www.writersdigest.com/writing-articles/by-writing-goal/write-first-chapter-get-started/hooked-on-a-feeling
- http://www.writersdigest.com/online-editor/how-to-make-ordinary-characters-compelling
- http://www.dummies.com/how-to/content/develop-childrens-book-characters-through-writing-.html
- http://mens-en-samenleving.infonu.nl/ouder-en-gezin/108250-25-tips-om-kinderen-naar-buiten-te-krijgen.html
- http://www.theguardian.com/books/2011/oct/23/recommended-reads-children-8-10
- http://www.boekenkraam.nl/categorie/14132000/Kinderboeken_tot_10_Jaar/
- https://en.wikipedia.org/wiki/Category:Characters_in_children%27s_literature
- http://www.Robynopie.com/articles/writingforchildren_creatingbelievablecharacters.htm
- https://www.personalitypage.com/html/kids/EFJ.html
- http://www.16personalities.com/articles/our-theory
- Carver and Scheier [1]
- Davies [2]
- Singer and Doornenbal [3]
- titles for the bibliography sections are adaptations of lyrics from Billy Joel's *Piano Man*

References

[1] C. S. Carver and M. F. Scheier. *Perspectives on personality*. Pearson Higher Ed, 2011.

[2] H. Davies. *Understanding Children's Personal Lives and Relationships*. Palgrave Macmillan, 2015.

[3] E. Singer and J. Doornenbal. Learning morality in peer conflict a study of schoolchildren's narratives about being betrayed by a friend. *Childhood*, 13(2):225–245, 2006.

B.2 Persona description of Robin

Robin NAO

"Strive to make something of yourself, then strive to make the most of yourself."

Age: 10
Work: Care Robot (CR)
Family: all NAO robots

Personality

Introvert	Extrovert
Analytical	Creative
Conscientious	Relaxed
Passive	Active
Judgmental	Open
Thinking	Feeling
Reserved	Warm
Serious	Lively
Trusting	Vigilant

Creative | Social | People-Pleaser

Frustrations

- Robin has a condition where emotional or physical arousal can cause him to overheat and eventually pass out. He hates this.
- Robin does not like soccer but most other male NAOs do. He wishes they would be more open-minded.
- Robin is finding that after his time with Marco, it is not so easy for him to trust others as it was before.
- Robin does not like how one of his robot classmates bullies everyone.

Bio

Robin NAO was created in a factory in France in 2011. Robin was made for stock, and consequently lived in the NAOsery with some of his brothers and sisters for a total of eight months. He was popular with his sisters and younger brothers, but his older brothers were too competitive for his taste, and liked soccer too much.

Early in 2012, he was bought by a rich family for the 9th birthday of their son, Marco. For the first two weeks, Marco treated Robin like a friend but soon lost interest. Marco's younger sister, Veronica, even liked to abuse him with severe shaking and drawing on him. After one year, Marco put Robin with his other old toys in the attic. There he made many friends. Another year went by like this until Marco's father decided to donate Robin to a local hospital after reading a newspaper ad shortly before Christmas in 2013.

The hospital has been the perfect place for Robin to grow and develop his personality. He shares a room with his sister Alex and his best friend Danni. He attends school together with other robots at the hospital. At school, they are tought to understand and take care of humans. He is developing his expertise in the area of diabetes care for children. This requires him to work closely with doctors, nurses, researchers, children, and their parents to ensure that children receive the best care possible. He loves his job because he loves people and nutrition. He is treated well at the hospital and has known to integrate himself very well, both with the healthcare professionals and the robot community.

Goals

- Robin wants all diabetic children to be able to cope well with their disease.
- Robin wants to earn other people's and robots' respect and affection. He tries to avoid conflict.
- Robin is very interested in the human metabolism and food. One of his life goals is to allow robots to taste human food.
- Robin would really like to one day be able to openly dance in front of a crowd without having to be ashamed.

Motivations

Harmony
Fear
Achievement
Growth
Power
Social

Important People/Robots

- Alex: sister, CR for autistic children
- Danny: best robot friend and CR for elderly
- Elmo: classmate, CR for cancer patients
- Chris: bully, receptionist robot
- Marco: previous owner, now a teenager
- Veronica: Marco's younger sister and a passionate robot abuser
- Nurse Anna: human crush

B.3 Design rationale

Robin Nao

Personality Rationale

“”

Personality

Personality traits were selected by first choosing traits that appeared sensible for the given domain (extraversion, conscientiousness, warmth, high-energy, playfulness) and then finding a suitable Myer-Briggs Personality Type for children (`https://www.personalitypage.com/html/kids/EFJ.html`) to integrate these traits into one coherent personality, and to obtain insights into reasonable additional negative qualities (fear of change, inability to digest criticism, high need for praise, people pleaser) but also additional positive qualities (determination, creativity, curiosity). .

Extrovert **Robin must interact with many children, researchers, doctors, and parents. He must give presentations, entertain, engage, and explain himself continuously. These tasks could well be too much for an introvert. The fact that he has to talk in many situations fits well with an extrovert, who actually enjoys talking about himself. In addition, for my specific project, he should be an opener, someone who encourages another to openly disclose. Scores on the Opener Scale correlate positively with self-esteem and negatively with shyness. As a result of these considerations, an extroverted personality seems more suited.**.

Conscientious **One of the goals of PAL is that children become increasingly self-reliant in their diabetes management. It is important that they are conscientious in the choices they make related to their disease. Robin was chosen to be conscientious to serve as a role model and to be believable when giving advice. Furthermore, children should trust the robot to handle their data respectfully and to be on top of things. This is more in line with a conscientious personality.**.

Warm **Robin is a warm character. This is important so that the children feel comfortable and accepted around him. Warm personalities are more agreeable than colder ones (compare, for example, Wiggins interpersonal circle), and it is certainly of interest that the children like the robot.**.

1/4

Feeling **Robin makes decisions more based on what feels right, including considerations of other people that are affected by the decision, rather than on what makes the most sense objectively. Rationalism is not for him. This fits well with his warm and caring personality. In return, he also appreciates it when he is considered.**.

Judging **For the same reasons that Robin was chosen to be conscientious, he was also chosen to be judging rather than feeling. He is organized and thrives more in structured environments. This makes the hospital a good place for him. His need for structure also makes him suited for the peer-mentor role that he holds for the children with regard to their diabetes. A robot who would be chaotic and lose track of goals that were agreed upon, forget or how well the patient has been doing lately, or not show up to an appointment is not desirable.**.

Active **Robin is active for similar reasons as he is extroverted. His lifestyle requires him to be energetic and to put the energy to good use. He should encourage and motivate children to be active and take responsibility. He should never not feel like playing or chatting with a patient, because that's his whole purpose in life.**.

Open **Robin is generally open, but he also has some inflexible opinions on what is wrong (e.g. cheating). He should be tolerant of children making mistakes, and he should also make some mistakes himself. However, he is not very tolerant of being criticized. He does not necessarily show this, but he does remember. This is typical for the EFJ-personality (compare `https://www.personalitypage.com/html/kids/EFJ.html`). Since Robin's main current goal is to help humans, he must try to understand them to the best of his ability. As a result, he is curious to learn about their world views and feelings. He has learned that if he judges too quickly, people may get offended and will not disclose further.**.

Biography

During the creation of the biography, it was the goal to create a story that is both relatively in line with the fact that robots are not human and in line with a character that children can embrace. This dualism is supported by the Latitude study published in the report Robots @ School in 2012 (`http://latd.tv/Latitude-Robots-at-School-Findings.pdf`).
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NAOsery **This is an important time in Robin's life because although he is not needed somewhere in the world straight away, he is not alone. Instead, from the very beginning, he is surrounded by many others that are his equals. According to Sullivan and Piaget (compare [1]), it is through interactions with peers that children learn to become social beings, to compromise, to become interpersonally sensitive. While parents are an authority in children's learning about the world, peers are equals. Only when children learn to cooperatively construct world order with their peers can meaningful interactions result. This social learning takes place in the NAOsery for Robin. It is here that he becomes a truly socially competent robot.** .

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Marco **This phase in Robin's life was included because of my personal experiences. Having grown up very sheltered and without any real troubles but having had friends with difficult childhoods, I learned that troubled children or teenagers do not think that sheltered children can truly understand or relate to them. They are probably right. For this reason and to protect their otherwise innocent friends, they are sometimes reluctant to share their problems. Therefore, I decided to give Robin a somewhat problematic but not overly dramatic life episode. I do not believe that this, seeing as it is not overly dramatic, will cause feelings of alienation for sheltered children but may make more troubled children feel better understood. Such a troubled phase is also likely to lead to more maturity, which is a good thing to be associated with Robin, since children should develop a mature attitude towards their diabetes management. Furthermore, on** `http://fmwriters.com/Visionback/Vision56/Vision1.html`**, it is advised to make the character slightly older than the children, because children like to learn about what older children do, rather than younger ones. Additionally, it is important that Robin, who loves to be around others, also learns to handle being alone, because the children may witness such situations at the hospital or in the camp and should not consider it necessary that the robot be entertained all the time.**.

Hospital **This sets the stage for the present. Children should imagine Robin living in a pleasant environment where he is comfortable. They should also believe that Robin enjoys his daily work and especially that he enjoys talking to them and playing with them. Furthermore, since it is his job to be there for them, they hopefully consider it logical that he is available whenever they should need him. It is also important that he has a positive attitude especially towards the doctor, so as not to lessen any impression that children might have. This is also sensible in light of his people embracing personality. Robin only dislikes people when they show character traits that he disapproves of (e.g. unfairness). Since the children are all school-aged, it makes Robin more relatable when he also goes to school. Having a sister around allows for sibling related disclosures. Just like the child, Robin has a parallel life that the child is not a part of, and a robot friend group that is distinct from his human friends. This allows for more depth and activity in his life and consequently for more stories to tell.**.

Additional Aspects

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Food **Robin was given an intrinsic interest in human food and nutrition to warrant his extensive knowledge in the field. Since Robin should be an expert on diabetes, this also requires that he knows much in the field of human nutrition. To make the field appear even more interesting to him, robots do not get much variety in their food. This actually matches with the fact that robots live on electrical power and there is not much variety in electrical power.** .

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Health-care **Robin's personality causes him to care about the well-being of others. Especially since children are young and ideally carefree, he thinks that it is important that diabetes does not govern their lives. Therefore, it is his goal to support them as much as possible in their quest to gaining control over their disease.**.

Condition **It is not intended in the PAL project that the robot also has diabetes and that the child and the robot need to learn about diabetes together, or that the child teaches the robot. Instead, the robot should function as a very knowledgeable friend, whom they can consult if they have problems and who provides informed suggestions for example when setting self-management goals. However, to feel better understood and to see the robot as one of them, he was also endowed with a health condition. Since NAO robots have a tendency to overheat with time, Robin was given a heat condition. This can interfere with his life in much the same way that diabetes can interfere with the lives of the children.**.

Dance **Although several websites (compare** `http://www.writersdigest.com/online-editor/how-to-make-ordinary-characters-compelling`**) advise not to necessarily make characters too unusual, but rather to have unusual things happen to them, Robin was given a deep secret. Namely, that he is very passionate about dancing, something that is highly unusual for a male European robot. He tries to hide this very much, even from his sister and best friend. He often pretends that he does not enjoy it so much and that it is just something that researchers and the hospital staff like for him to do. David Corbett argues that compelling characters need a secret to "inform us of what our characters have to lose, and why"(**`http://www.writersdigest.com/writing-articles/by-writing-goal/write-first-chapter-get-started/hooked-on-a-feeling`**).**.

Human Crush **Having crushes plays a central role in children's lives in the target age group. It is a recurring theme in many stories written by children, often appearing as a secret that at best only selected friends know about (compare** `http://www.web4kids.nl/verhalen/`**). As a result, the robot was also given a crush on one of the nurses. Ideally a nurse that the children also know. That the robot is willing to share the identity of his crush is likely to be interpreted as a sign of great trust and close friendship by the children. If the child is familiar with the crush, it becomes a shared secret about a mutually known person and can thus potentially even strengthen the bond between child and robot.**.

Referenties

[1] James Youniss. *Parents and peers in social development: A Sullivan-Piaget perspective*. University of Chicago Press, 1980.

4/4

C Development of DIRS: Bottom-up

An extensive and critical review of existing rating scales and scaling methods for intimacy of self-disclosure preceded the development of our own rating scale. This section provides a documentation of said process.

C.1 Background

"Conceptually, self-disclosure has been defined as any information about oneself that a person verbally communicates to another person. This includes both descriptive information (such as one's political affiliation) and evaluative information (such as how one feels about starting college). Any communication, then, can vary in the degree of self-disclosure present. Degree of disclosure is typically evaluated along the dimensions of depth (quality) and breadth (quantity). Depth refers to the intimacy level of the disclosure, whereas breadth refers to the amount of information exchanged. The most common method of operationalizing self-disclosure is to manipulate or measure its level of intimacy (depth) such that intimate topics (e.g., one's feelings about marriage) are considered higher levels of disclosure than are less intimate topics (e.g., one's favorite musical group). Disclosure breadth is typically operationalized as the amount of time spent talking about oneself or the number of self-relevant statements made during an interaction." [13, p.458]

C.2 Self-disclosure research: A brief history

Deciding to study self-disclosure for the first time can be likened to stepping into a closet and discovering Narnia [33] on the other side. Since approximately 1950, self-disclosure has captured the interest of an ever increasing number of researchers. Pioneers in the field were Taylor and Altman, who developed the social penetration theory as a result of their inquisitions into self-disclosure behavior of young adults. The theory posits that as people advance from strangers to friends or partners, they share an increasingly large amount of themselves with the other. This shared content is referred to as "self-disclosure" and proceeds along the two dimensions *breadth* and *depth*. Breadth can be understood as the number of different topics one shares with another, while depth describes how intimately a certain topic is discussed. Social penetration theory set off an avalanche in disclosure research, mainly concerning dyadic relationships between various disclosers (e.g. children [38, 39, 40, 48], adults [18, 41], different ethnicities [29], or neurotic personalities [9]) and various target persons (e.g. mother, father, best friend, stranger, etc. [21, 46, 51]

in various contexts (e.g. therapy [24], single-career vs. dual career couples [37], or marriage [32]). These examples can be extended nearly ad infinitum (see [26] for a review). In his survey on the operationalization of self-disclosure, Tardy [45] further notes that over time and with increasing variety in the research areas of interested scholars, different perspectives were taken on disclosure. Early psychologists viewed self-disclosure as an individual trait, later ones as a feature of relationships. For those with a communication theoretical background, self-disclosure was regarded as a characteristic of a message.

Figure 9 shows a cumulative plot of the number of publications related to self-disclosure for each year since 1900. The rate of publications on self-disclosure increases steadily from approximately the year 1950 until the mid 1990's, from whereon the slope steepens. This can be attributed to the larger relevance of computers and the internet in everyday life. According to Trepte and Reinecke [47], two generations of self-disclosure in computer mediated communication (CMC) can be distinguished. The first generation was mainly concerned with dyadic interactions as occurs in online chatting. Here experimenters mediate verbal exchange of participants in a laboratory setting with a computer and compare breadth and depth of self-disclosure with that of normal face-to-face (FtF) conversations. In the second generation, however, social networking services had grown in popularity, reinstating some of the social cues that were lacking in the first generation research. Furthermore, self-disclosure in a one-to-many relation was now of interest. It appears that the increase in self-disclosure interest of this second generation is reflected in another steep increase in Figure 9 in the year 2007.

C.3 Definitions of self-disclosure and intimacy

While it is certainly best practice in research to clearly define the concepts one uses, this is done strikingly meticulously in the self-disclosure literature. It is not coincidental. The definition chosen has large consequences for the operationalization that is then employed. The two most commonly used definitions are exemplified in the following two statements:

- [5, 15, 42, 52]: "self-disclosure may be defined as that which occurs when A knowingly communicates to B information about A which is not generally known and is not otherwise available to B."
- [10, 20, 28] : "verbally communicating personal information about the self to another person."

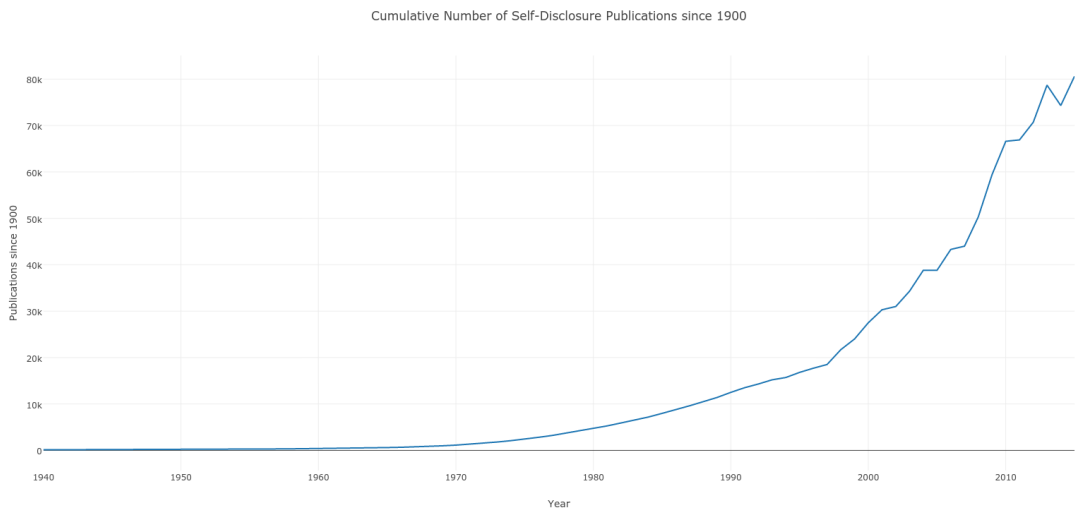


Figure 9: The plot shows the cumulative amount of publications related to self-disclosure since 1900 for each year from 1940 until 2015. The values were obtained by noting the number of search results for the search term "self-disclosure" from 1900 - x using Google Scholar. Citations and patents were excluded.

Thus, the assessed depth of disclosure depends on whether the definition encompasses all kinds of statements that one may direct towards another or only those that are personal. The former would include such information as ones name or age, the latter would not. Here, the more inclusive definition will be adopted, because this allows for a larger range of levels to study reciprocity behavior on.

C.4 The present context

The extent to which knowledge from dyadic interaction in FtF or CMC communication transfers to human-robot, or more generally to human-artificial agent interaction, is still largely unexplored. This is where the present study comes in. The intent of the here presented research is to provide insights into how diabetic children (ages 8-10) reciprocate the disclosures of an artificial companion agent. One aspect that is of interest, for example, is whether children model the topic and intimacy level of the agent. To this end it is necessary that a set of disclosure statements of the agent can be created and depth of children's disclosures can be assessed, preferably using one and the same scale. To create disclosures at various depths and train raters, each intimacy level must be very clearly defined. Furthermore, patterns in modeling behavior can be examined more closely when the scale consists of more than three

levels. To keep the design and rating relatively straight-forward, a unidimensional scaling was also desired. In an attempt to find a scale matching these criteria, the self-disclosure literature was studied.

C.5 Scaling considerations

Upon reviewing the relevant child and adult literature on self-disclosure, no entirely suitable intimacy scale could be found. This is somewhat surprising given that "investigators have favored developing new scales rather than using ones from prior studies" [45, p.332]. As the statement holds true beyond the year 1988, it cannot be said with absolute certainty that *all* existing operationalization methods were reviewed. Thus, an equally useful or even better scaling method than the one developed in Section C.6 may well exist.

C.5.1 Number and definitions of levels

In the child literature, usually only two (low and high) [39, 40] or three (low, medium, and high) [11, 19, 38] levels of disclosure depth were employed. There was a general lack of consistency across papers in definitions of low and high disclosure. While for some authors low intimacy included only biographical facts or descriptions of activities [40], others also considered certain expressions of feelings or attitudes low in intimacy [48]. If a medium disclosure level is included to span only preferences, as is done in [19, 22], this implies the following two sentences being of equivalent depth:

1. "I really like strawberry ice cream."
2. "I don't like having non-white friends."

In the adult literature, similar three-tiered scales can be found, both in the very early as well as in the CMC literature (for example, [12, 16, 30, 43]). [45] notes that one way of ensuring that the intimacy contrast between self-disclosure statements is not unnaturally high, is by using three or more categories. Many authors that use such a finer granulation of intimacy, though, obtained this by designing or collecting a battery of disclosure statements and having a large number of people rate them on 5, 7, 9, or 11 point scales [1, 52]. Since such a scaling is obtained empirically, they often do not conceptualize and clearly define the anchors of their scales but instead simply use examples (compare [31]). Several authors also ask participants to rate disclosures on a Likert-scale from not at all intimate to very intimate without providing any further guidelines on which raters can base this judgement (compare

[34, 49]). Yet others do not detail how raters were trained to make judgements on a scale (compare [20, 27]).

Clear definitions and descriptions are provided for the revealingness in spoken behavior (REV) scale. However, the scale cannot be applied in this study, since it asks the interpretation of such speech signals as the tone of voice. Interestingly, Davis and Sloan [18] measured depth of self-disclosure and emotional investment as operationalized by paralinguistic speech characteristics separately only to later drop the latter measure due to its very high correlation with the former.

The 5-point scale developed by Rubin [41] to assess depth of self-descriptions provided by airport passengers is one of the most clearly defined scales for written self-disclosure. It informed the design of a new scale for this project, but was not considered entirely adequate. The study was carried out at an airport and participants were asked to disclose in writing following an example of either low, medium, or high intimacy from the experimenter. The scale is criticized by Archer and Berg [3] for not providing sufficient flexibility. They repeated Rubin's study but did not allow the topic of the experimenter's initial disclosure to vary (three disclosures about drinking). All three initial disclosures would have scored as level 4 on the Rubin scale, but were actually considered to be of low, medium, and high intimacy by the authors. They therefore created a separate 5-point scale but do not specify the anchors. Instead they use six criteria of intimacy provided by Taylor and Altman to guide raters' judgements. The scale created for the here presented project will therefore aim to distinguish the three experimenter disclosures of [3].

The intimacy rating scale (IRS) [43] sensibly defines its three intimacy levels (non-intimate, moderately intimate, highly intimate) through the relationship between discloser and recipient (barely acquainted, fairly close, closest of friends), assigning approximately 10 disclosure topics to each category. However, the topics were derived from the self-disclosure battery of Taylor and Altman [46], which was created for studies with adults more than 50 years ago and scaled for intimacy by adolescent sailors and college students. Irwin Altman[8]: "I would seriously question the validity of the scaling for present day users, given how social relationships have changed over the years." The same objection holds for many other scales, derived from the same original battery (compare, for example, [21, 37, 42].

C.5.2 Categorical and topical scales and measures

In several reports, authors [28, 43, 46] have matched certain disclosure topics (for example, *sexual experiences* or *family*) to a certain intimacy level, not taking into

[8] e-mail correspondence with Irwin Altman, 12.12.2015

consideration that the subsequent two pieces of information can be regarded as very different in intimacy:

1. "I am heterosexual."
2. "I am homosexual."

This practice is often criticized in the literature, since it is rather obvious that most topics can be discussed at various depths. For example, although the general topic *Body* is considered to be more intimate than the topic *Money* in the Jourard Self-Disclosure Questionnaire (JDSQ) [28], a woman saying something like "My New Years resolution is to shed the Christmas pounds before the summer." would probably be considered lower in intimacy than laying out how one has trouble managing ones finances.

In a similar vein, in some approaches a specific level consisted of a subset of specific disclosure categories. For example, in [30], the *peripheral* level comprised [biographic data], the *intermediate* level [attitudes, values, prejudices, opinions, aspirations, dreams, desires], and the *core* level [basic values, beliefs, needs, fears, self-concept, emotions, feelings, shame]. Although this appears sensible upon first glance, it is a simplification. For example, it could be argued that there is a difference between stating ones first name and telling someone where all one has traveled to, which would both fall into the category of biographic data. Similarly, expressing that one likes a certain movie is hardly equally as intimate as expressing that one is in favor of the death penalty.

[31] thus constructed a non-categorical, non-topical scale for discretizing intimacy of disclosure statements. The resulting scale is example-anchored, has ten points, and is based on the four criteria: topic, experiencing level of discloser, spontaneity/directness, and empathy of recipient. Although these are good considerations, the scale was developed from examples provided by college students and the example-anchored scale is therefore hardly of use for other populations. A non-topical questionnaire was also designed by Wheeless and Grotz [50], arguing that the perceived intimacy of a disclosure topic is subjective. The questionnaire, using neither categorical nor topical items, assesses various dimensions of self-disclosure as self-reported on a fairly abstract level.

C.5.3 Dimensions of intimacy

It is not uncommon to find researchers using a multidimensional approach in rating disclosure depth. One of the most common of these is the distinction between *de-*

scriptive (facts about the self that are private) and *evaluative* (opinions and feelings one has) intimacy [4, 24, 36].

Frequently, valence of disclosure is also regarded as a separate dimension from depth [21]. However, these are not entirely independent. For example, very highly intimate disclosures tend to have a negative valence. Gilbert and Whiteneck [21] seem to have encountered this problem after asking 24 subjects to rate 100 modified statements of the Taylor and Altman battery on personalness and valence. They note that "there were some segments of the personalness-valence matrix which contained only a few or none of the items as rated by the subjects" [21, p.348]. They do not specify which segments, though.

Some authors argue for using more objective measures of self-disclosure depth. For example, Antheunis et al. [2] use the amount of disclosure on five intimate disclosure topics to assess self-disclosure. Cash and Soloway [7], Hargie et al. [23] employed counts of self-references in positive, negative, or neutral contexts to measure disclosure depth. Similarly, the length of disclosures has been found to correlate with their intimacy [18].

The scale developed in Section C.6 attempts to capture intimacy on one dimension. This is done for the sake of simplicity and because it corresponds to an intuitive notion of intimacy. The distinction between descriptive and evaluative intimacy reflects more a difference in statement types than in their intimacy. Since the inclusive definition of self-disclosure was decided for in this research project, valence as a separate dimension would require the development of valenced, low-intimacy statements; a difficult task. Additionally, neither the amount of self-references nor the length of disclosure were included as intimacy criteria in the scale. Increasing the amount of self-references with depth would be too difficult to consciously do in designing a battery of disclosure statements. Increasing the length of self-disclosures with depth would bias raters. Thus, a conscious effort was made to standardize disclosure length in the agents battery of disclosures.

C.6 New scale

As a result of shortcomings or the inapplicability of the reviewed methods, it was decided to develop a new scale as a synthesis and refinement of prior work and for the specific purpose of children interacting with ECAs. This task was approached as in [31], i.e. by first identifying possible facets of disclosure depth. However, neither *topic*, nor *spontaneity*, nor *empathy of recipient* were fitting for the here presented study. As already argued above, there is not much of a basis for matching *topics* in their entirety to a specific depth level [36, 42]. *Spontaneity* is not a useful criterion

in this particular context, since it is expected that all disclosures will be relatively spontaneous and only marginally linked to the context of the interaction. *Empathy of recipient* cannot be taken into consideration because it would require an extensive layer of additional intelligence, both for the agent to predict the child's empathy and to respond empathetically. The ECA discloses to the child regardless of whether the child reacts in an empathic manner and it is equally hoped that the child's disclosure behavior is not so much dependent on the reaction of the avatar, but rather on the proaction. The fourth criterion, *experience level*, of [31] was adopted to some degree in the facet *emotional involvement*. The five identified facets, in order of significance, are as follows:

1. evaluability: is the piece of information something that can be subjected to evaluation?
2. cognitive involvement: does the discloser voice his/her own thougts or opinions without great emotional involvement?
3. emotional involvement: is the discloser emotionally involved in the topic?
4. vulnerability: does the discloser make himself vulnerable through this disclosure?
5. social stigmatization: is there a social stigma associated with the topic of disclosure?

From these considerations, a total of six different intimacy levels resulted. These are illustrated in Figure 10. Table 5 then defines and illustrates the six levels by providing examples. The facets are inclusive, with each *deeper* one encompassing all prior ones. It is important to note, that the scaling does not say that a level 0 disclosure, like "My address is ...," cannot have emotional value to the discloser. The scaling is instead intended to aid the categorization of disclosures by a third person and disclosures such as "My address is..." do not reveal such emotional involvement.

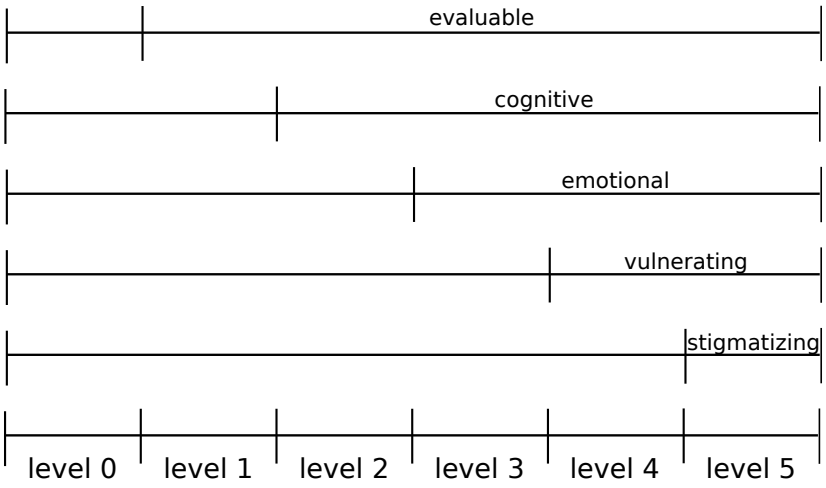


Figure 10: Illustrated are the six levels of intimacy and how they relate to the five identified facets of self-disclosure depth.

Levels	Definition	Abstract Examples	Concrete Examples
0	Non-private, descriptive information that cannot be subjected to evaluation, because the discloser is not responsible. This is information one would share with anyone.	Demographic Information, circumstances.	• "My name is Bas." • "I live with my family in the Netherlands." • "Yesterday, I saw someone being chased by the police."
1	Slightly more revealing information than level 0 in that there is some agency involved. However, no true insights, because information is non-private.	Banal choices or decisions, activities.	• "I regularly brush my teeth." • "I went to the movie theater 20 times in my life." • "Some days, I watch TV after school."

2	The disclosed information is shallow but allows first insights into cognition of agent. Information that one would share with an acquaintance, or a more distant family member.	Own low-risk (i.e. not likely to be critically received) opinions, preferences, minor desires or wishes that are not long-lasting	• "I think bragging is dumb." • "My brother listens to Death Metal all day, really loud. Usually I act quite annoyed, but some of the songs I actually like." • "I'd really like to go shopping some time this week."
3	Topic of disclosure is important to the discloser. The disclosures often reflect some affective involvement. If recipient passes information on, there are no serious consequences for the discloser. One may say these things to a peer.	Goals and aspirations, strong opinions, strong emotional involvement, certain successes and failures	• "I desperately want to get one 10 this year. I've been studying a lot. My best chances are probably in biology. It's tough, but I think even if it doesn't work out, I may end up with a 9 or so." • "I got in a fight with my friend. We sit together at school and she would always put her things on my side of the table, and it greatly annoyed me. I feel somewhat bad for getting angry and shouting at her. I apologized and we're friends again, but now we sit separately." • "A few weeks ago, my hamster died. I was very sad!"
4	Topic of disclosure is very intimate and makes the discloser vulnerable. If recipient is not trustworthy, consequences may ensue. Thus, such information would only be shared with a close friend.	Deep fears, criticism of people that are important, deep desires, embarrassing experiences, regrets, failures	• "For more than a year now, I've had this really big crush on a boy at my school. He's one grade above me, but he's soooo cute! I could never tell him, though!" • "I think I'm too fat." • "I don't like my mom's cooking. She always burns things or puts in too much salt. I can't tell her, though, because then she would probably get sad." • "Yesterday, my mom walked in on me looking at naked men on the internet. I think we were both very embarrassed."

5	Not only does the disclosure make the discloser vulnerable, the social stigma associated with the disclosure could also lead to withdrawal of the recipient and thus risk the relationship. Revealing some undesirable, likely to be permanent characteristic of discloser.	Same categories as in level 4, but stigmatizing information	• "Sometimes I wet my bed." • "I have started shoplifting last year. I know it's wrong, but it's so easy." • "There's this one boy in my class, and he really likes programming and math and all these nerdy things. He has bad eyes and needs glasses. We pretended to be his friends during lunch so that he would give us his glasses and then we hid them. When he couldn't find them after an hour, he cried. Eventually, he asked the teacher for help. I feel ashamed of what we did."

Table 5: Definitions of anchors of new scale for the derivation and labeling of self-disclosures at various intimacy levels.

C.7 Levels of intimacy in related literature: Children

Reference	Levels	Explanation	Examples
[19]	low	external characteristics	"My parents are called Tarzan and Jane."
	medium	preferences	"I really hate pancakes"
	high	personality characteristics	"I worry a lot about my diabetic sister."
[40]	low personal	descriptions of environment	"Our house has 10 rooms."
		descriptions of people and activities	"I have a brother."
	high personal	personal preferences	"I like skipping rope."
		positive personal	"I'm really good at chess."
		negative personal	"I am fat."
[11]	used intimacy rating scale (IRS) presented in [43]	see adults table below	no examples given
[39]	low	list labeled by children	"My teacher is a woman."
	high	list labeled by children	"I told someone a lie."
[38]	low	list labeled by children	"I have my own room."
	medium	list labeled by children	"I don't like different kinds of food, such as liver."
	high	list labeled by children	"Yesterday, I broke my mother's lamp."

Shows some of the important rating scales for intimacy as can be found in the self-disclosure literature with children as subjects.

C.8 Levels of intimacy in related literature: Adults

Reference	Levels	Explanation	Examples
[25, 30]	peripheral	biographic data	"I am 30 years old"
	intermediate	attitudes, values, prejudices, opinions, aspirations, dreams, and desires	"I like to go shopping"
	core	basic values, beliefs, needs, fears, self-concept, emotions, feelings, shame	"I feel most guilty about cheating on my girlfriend"
[6, 16, 43]	non-intimate	information people would probably be willing to share with someone they did not know well	"I am 30 years old"
	moderately intimate	information people would probably share only with someone with whom they were fairly close	"I like to go shopping"
	highly intimate	material people probably would share only with one of their closest friends	"I feel most guilty about cheating on my girlfriend"
[8, 14, 17, 52]	1	collection of questions was labeled in intimacy on scale from 1-7	food preferences/favorite TV program
	⋮	by 51 female students, statements with high agreement were selected	
	7	for a final intimacy scaled questionnaire	ideas and experiences related to sex
[1]	1.66	No explanation for how scaling was done	The foods you like best
	2.11	is provided, but must have been similar to	What you like to do most in your spare time
	2.81	scaling reported in [52].	Your occupational plans for the future
	4.57	But seems to be an average score rather than agreement score	Questions in the area of sex you are most curious to know
	5.09	No information about raters given.	Characteristics of your parents that you dislike
	5.60	Only examples for high and low intimacy are given, hence gap between 2.81 and 4.57	What you feel the guiltiest about, or most ashamed of in your past

[9][9]	1 - little information given	The person refuses to talk about himself; continually asks the other person to talk about himself; sits quietly, rarely says anything.	
	3 - superficial information	The person talks the entire length of time about superficial content.	mentions what movies he has seen, what classes he is taking, where he works part-time, superficial description of siblings
	5 - midpoint	The individual talks about personal feelings but not at an intimate level. This category is appropriate when it is difficult to decide if the person talks intimately or not	talks about career goals, what his girlfriend is like, views on dating, and the value of an education.
	7 - moderately intimate information	The person talks at a moderately intimate level.	might go into details about problems in getting dates, nervousness when speaking in class, problems about being too fat, feelings of guilt.
	9 - extremely intimate information	The person talks about material which is very personal, embarrassing, or emotional.	mentions specific details about sexual experiences, wanting to commit suicide, details of family disruption because of an alcoholic parent, or descriptions of homosexual feelings.
[44][10]	0 - No talking	No verbal or vocal behavior.	
	1 - Description of Externals	Subject does not talk about himself, material is presented wth no feeling. Stating things one would be willing to say to a potentially unfriendly or threatening person.	external events, intellectual ideas or theories.
	2 - "Cool" Attitude About Externals	Not about self but external events, but is willing to reveal his relationship to these events. Style is unemotional, intellectual, not strong.	Attitudes, opinions, evaluations are shared . No socially undesirable statements.
	3 - Remote Observer of Internal Experience	Talks about himself but without self-involvement. Style of expression is externalized, intellectualized, mechanical, distant.	Things that one might say in public to a mere acquaintance.
	4 - Internal Observer with Momentary Involvement	Style of level 3 but with momentary self-involvement.	Sharing of things that one might say to someone who seems trustworthy but with whom one has not has a close intimate relationship.

[9] 9 point scale of which only uneven numbers were labeled.
[10] REV-scale for the measurement of revealingness in spoken behavior, Appendix III

	5 - Internal Narrator	Expressing oneself with self-involvement and feeling	Revealing oneself the way one would to a trusted friend, no attempt to present oneself in a socially favorable manner.
	6 - Searching for New Meanings or Fresh Expression of Feelings	Actively trying to explore personality/world. Discovering new feeling or new aspects. Speaking with spontaneity and feeling in voice.	One's values, perceptions of others, relationships, fears, life choices. Manner reserved for trusted friends.
[27]	scale from 1-10, two raters	Each rater was given a definition of intimacy as "information that makes the discloser feel vulnerable in some way, for instance, emotionally vulnerable." The measure was calculated using the mean of the two raters' scores. The inter-rater reliability was 0.76.	no examples
[35][11]	0	no verbalization	
	1	superficial, closed, inhibited, reserved	
	3	moderately personal, somewhat revealing of feelings	
	5	personal, revealing of feelings, involved, open	
[42][12]	3.00	My views on drinking	
	5.43	My feelings about how much independence I need.	
	7.50	My views on sexual morality. How I feel that I and others ought to behave in sexual matters.	
[36]	Category 1	Highly private facts and highly personal feelings or judgments	I am ashamed of my drug dependence."
	Category 2	Highly private facts	I was once a heroin addict
	Category 3	Highly personal feelings or judgments	I absolutely detest loud music.
	Category 4	Relatively public facts and a low level of feelings or judgments	I usually play my stereo in the evenings.

[11] 7 point scale of which only uneven numbers were labeled.
[12] 10 point scale, only three examples are provided.

[41][13]	Little or no disclosure	Airport itinerary; shifts focus away from self (e.g., "good luck"); trite, uninformative quotes; observations about the airport.	At the present time I am at Logan International Airport enroute to San Fran and then on to Okinawa.
	Superficial disclosure	Public aspects of self, e.g., demographic, census-type data; general reason for being in airport or taking trip. No emotions or attitudes are expressed other than conventional wisdom about air travel or conventional advice to experimenter.	My name is Judy. I have lived near Boston for one year. Originally though, I'm from North Carolina.
	Conventional disclosure	More detail than (2), e.g., details about occupation, facts about family, detailed purpose or events of trip, experiences in airport. If emotions or attitudes are expressed, they are relatively stereotypical and uninformative.	My name is Ann Peterson and I live in Atlanta. I am very interested in Mental Health and have been associated with a child psychologist. We work with emotionally disturbed children and their parents in a clinical setting.
	Personal disclosure	Attributes of a more personal nature, e.g., income, health. Emotions, perceptions, attitudes, intentions, and other internal states which go beyond the merely conventional.	I am a mother, a wife and a career woman. Each has enhanced the other. However, it has at times made me organize better & appreciate the problems of people who have had fewer resources to make this combination. Nor would I recommend it except for those willing to work and take the bruises.
	Intimate disclosure	Aspects of self which are clearly intimate, e.g., sex life; reflections of one's self-concept, ultimate purposes; religious, political, and other attitudes which seem central to one's self-concept.	My name is Frank Birch. I am a foreman on third shift at Superior Carton Co. One thing I regret in life was not following my ambition to become a teacher and football coach. I am married and have a little daughter 2 years old. Without my daughter my life would be nothing. I thank God for bringing my daughter to me.

Table 6: Shows some of the important rating scales for intimacy as can be found in the self-disclosure literature with adult subjects.

References

[1] K. Ando. Self-disclosure in the acquaintance process: Effects of affiliative tendency and sensitivity to rejection. *Japanese Psychological Research*, 1978.

[2] M. L. Antheunis, P. M. Valkenburg, and J. Peter. Computer-mediated commu-

[13] study was conducted in an airport terminal, hence so many airport related examples.

nication and interpersonal attraction: An experimental test of two explanatory hypotheses. *CyberPsychology & Behavior*, 10(6):831–836, 2007.

[3] R. L. Archer and J. H. Berg. Disclosure reciprocity and its limits: A reactance analysis. *Journal of Experimental Social Psychology*, 14(6):527–540, 1978.

[4] J. H. Berg and R. L. Archer. Responses to self-disclosure and interaction goals. *Journal of Experimental Social Psychology*, 18(6):501–512, 1982.

[5] J. J. Bradac, L. A. Hosman, and C. H. Tardy. Reciprocal disclosures and language intensity: Attributional consequences. *Communications Monographs*, 45 (1):1–17, 1978.

[6] M. B. Brewer and J. Mittelman. Effects of normative control of self-disclosure on reciprocity. *Journal of Personality*, 1980.

[7] T. F. Cash and D. Soloway. Self-disclosure correlates of physical attractiveness: An exploratory study. *Psychological Reports*, 36(2):579–586, 1975.

[8] B. C. Certner. Exchange of self-disclosures in same-sexed groups of strangers. *Journal of Consulting and Clinical Psychology*, 40(2):292, 1973.

[9] A. L. Chaikin, V. J. Derlega, B. Bayma, and J. Shaw. Neuroticism and disclosure reciprocity. *Journal of Consulting and Clinical Psychology*, 43(1):13, 1975.

[10] G. J. Chelune. Self-disclosure: An elaboration of its basic dimensions. *Psychological Reports*, 36(1):79–85, 1975.

[11] N. B. Cohn and D. S. Strassberg. Self-disclosure reciprocity among preadolescents. *Personality and Social Psychology Bulletin*, 9(1):97–102, 1983.

[12] L. Coleman, C. Paternite, and R. Sherman. A reexamination of deindividuation in synchronous computer-mediated communication. *Computers in Human Behavior*, 15(1):51–65, 1999.

[13] N. L. Collins and L. C. Miller. Self-disclosure and liking: a meta-analytic review. *Psychological bulletin*, 116(3):457, 1994.

[14] P. C. Cozby. Self-disclosure, reciprocity and liking. *Sociometry*, pages 151–160, 1972.

[15] S. A. Culbert. The interpersonal process of self-disclosure: It takes two to see one. *Sensitivity training and the laboratory approach*, pages 73–79, 1970.

[16] J. A. Cunningham and D. S. Strassberg. Neuroticism and disclosure reciprocity. *Journal of Counseling Psychology*, 28(5):455, 1981.

[17] D. M. Daher and P. G. Banikiotes. Interpersonal attraction and rewarding aspects of disclosure content and level. *Journal of Personality and Social Psychology*, 33(4):492, 1976.

[18] J. D. Davis and M. L. Sloan. The basis of interviewee matching of interviewer self-disclosure. *British Journal of Social and Clinical Psychology*, 13(4):359–367, 1974.

[19] R. M. Diaz and T. J. Berndt. Children's knowledge of a best friend: Fact or fancy? *Developmental Psychology*, 18(6):787, 1982.

[20] J. P. Forgas. Affective influences on self-disclosure: mood effects on the intimacy and reciprocity of disclosing personal information. *Journal of personality and social psychology*, 100(3):449, 2011.

[21] S. J. Gilbert and G. G. Whiteneck. Toward a multidimensional approach to the study of self-disclosure. *Human Communication Research*, 2(4):347–355, 1976.

[22] S. Glaser. *Toward communication competency: developing interpersonal skills*. Holt, Rinehart, and Winston, 1980. ISBN 9780030535468. URL `https://books.google.nl/books?id=D-aR65yBXPQC`.

[23] O. D. Hargie, D. A. Dickson, and C. T. Hargie. The effects of religious affiliation in northern ireland upon levels of self-disclosure of undergraduates. *International Journal of Adolescence and Youth*, 5(3):173–187, 1995.

[24] S. M. Harris, C. A. Dersch, and M. Mittal. Look who's talking: Measuring self-disclosure in mft. *Contemporary Family Therapy*, 21(3):405–415, 1999.

[25] E. E. Hollenbaugh and M. K. Everett. The effects of anonymity on self-disclosure in blogs: An application of the online disinhibition effect. *Journal of Computer-Mediated Communication*, 18(3):283–302, 2013.

[26] E. Ignatius and M. Kokkonen. Factors contributing to verbal self-disclosure. *Nordic Psychology*, 59(4):362–391, 2007.

[27] A. N. Joinson. Knowing me, knowing you: Reciprocal self-disclosure in internet-based surveys. *CyberPsychology & Behavior*, 4(5):587–591, 2001.

[28] S. M. Jourard. Self-disclosure: An experimental analysis of the transparent self. 1971.

[29] S. M. Jourard and P. Lasakow. Some factors in self-disclosure. *The Journal of Abnormal and Social Psychology*, 56(1):91, 1958.

[30] S.-H. Kang and J. Gratch. Virtual humans elicit socially anxious interactants' verbal self-disclosure. *Computer Animation and Virtual Worlds*, 21(3-4):473–482, 2010.

[31] D. S. Klos and D. F. Loomis. A rating scale of intimate disclosure between late adolescents and their friends. *Psychological Reports*, 42(3):815–820, 1978.

[32] G. Levinger and D. J. Senn. Disclosure of feelings in marriage. *Merrill-Palmer Quarterly of Behavior and Development*, 13(3):237–249, 1967.

[33] C. S. Lewis. *The Chronicles of Narnia (adult)*. Harper Collins, 2001.

[34] M. J. Mallen, S. X. Day, and M. A. Green. Online versus face-to-face conversation: An examination of relational and discourse variables. *Psychotherapy: Theory, Research, Practice, Training*, 40(1-2):155, 2003.

[35] R. S. Miller and H. M. Lefcourt. Social intimacy: An important moderator of stressful life events. *American Journal of Community Psychology*, 11(2):127–139, 1983.

[36] T. L. Morton. Intimacy and reciprocity of exchange: A comparison of spouses and strangers. *Journal of Personality and Social Psychology*, 36(1):72, 1978.

[37] L. B. Rosenfeld and S. M. Welsh. Differences in self-disclosure in dual-career and single-career marriages. *Communications Monographs*, 52(3):253–263, 1985.

[38] K. J. Rotenberg and N. Chase. Development of the reciprocity of self-disclosure. *The Journal of genetic psychology*, 153(1):75–86, 1992.

[39] K. J. Rotenberg and L. Mann. The development of the norm of the reciprocity of self-disclosure and its function in children's attraction to peers. *Child development*, pages 1349–1357, 1986.

[40] K. J. Rotenberg and D. Sliz. Children's restrictive disclosure to friends. *Merrill-Palmer Quarterly (1982-)*, pages 203–215, 1988.

[41] Z. Rubin. Disclosing oneself to a stranger: Reciprocity and its limits. *Journal of Experimental Social Psychology*, 11(3):233–260, 1975.

[42] V. Sermat and M. Smyth. Content analysis of verbal communication in the development of relationship: Conditions influencing self-disclosure. *Journal of personality and social psychology*, 26(3):332, 1973.

[43] D. S. Strassberg and K. N. Anchor. Rating intimacy of self-disclosure. *Psychological reports*, 37(2):562–562, 1975.

[44] D. I. Suchman. *Responses of subjects to two types of interviews*. PhD thesis, The Ohio State University, 1966.

[45] C. H. Tardy. *A handbook for the study of human communication: Methods and instruments for observing, measuring, and assessing communication processes*. Greenwood Publishing Group, 1988.

[46] D. A. Taylor and I. Altman. Intimacy-scaled stimuli for use in studies of interpersonal relations. *Psychological Reports*, 19(3):729–730, 1966.

[47] S. Trepte and L. Reinecke. The reciprocal effects of social network site use and the disposition for self-disclosure: A longitudinal study. *Computers in Human Behavior*, 29(3):1102–1112, 2013.

[48] S. I. Vondracek and F. W. Vondracek. The manipulation and measurement of self-disclosure in preadolescents. *Merrill-Palmer Quarterly of Behavior and Development*, pages 51–58, 1971.

[49] E. M. Waring and G. J. Chelune. Marital intimacy and self-disclosure. *Journal of Clinical Psychology*, 39(2):183–190, 1983.

[50] L. R. Wheeless and J. Grotz. Conceptualization and measurement of reported self-disclosure. *Human Communication Research*, 2(4):338–346, 1976.

[51] L. R. Wheeless and J. Grotz. The measurement of trust and its relationship to self-disclosure. *Human Communication Research*, 3(3):250–257, 1977.

[52] M. Worthy, A. L. Gary, and G. M. Kahn. Self-disclosure as an exchange process. *Journal of Personality and Social Psychology*, 13(1):59, 1969.

D Development of DIRS: Top-down

When reviewing existing scales (Appendix C), it became evident that one of the reasons for the myriad of different approaches may be the lack of an underlying theory or model to explain what truly makes one disclosure more intimate than another. As a result, additional literature was considered. This lead to a second six-level version of the intimacy rating scale based on a model of the risk associated with self-disclosure. This six-level scale was used as a basis for the validation study.

D.1 Intimacy of self-disclosure

D.1.1 Risks and rewards of disclosing

Several different authors have analyzed the reasons as to why people disclose and as a natural extension why people choose to withhold information. The following rewards have been associated with self-disclosure [2, 5, 8]:

- self-expression
- self/identity clarification
- social validation/approval
- relationship development/intimacy
- social control
- relief of distress

In contrast, several authors also identified the risks associated with disclosure [1, 3, 6]:

- being misunderstood
- rejection by listener
- reduction of one's autonomy and personal integrity
- loss of control or self-efficacy
- hurting or embarrassing the listener
- betrayal by listener

In [10], a negative relationship between depth of disclosure and the wish for social approval was found. Pasupathi et al. [9], on the other hand, describe the emotional valence of an event and how memorable it was as determinants of self-disclosure. Negative everyday events were more likely to be disclosed while disclosures about negative important events, like transgressions, were less likely. This matched their prior study showing that valence and whether or not the event was a transgression mainly determined the likelihood of disclosure.

D.1.2 Models of self-disclosure

Two models of how and when people choose to disclose could be found: the Disclosure Decision Model (DDM) and the Risk Revelation Model (RRM). The DDM [8] considers five goals of the discloser to motivate self-disclosure: social approval, catharsis, social control, intimacy, and identity clarification. If one of these goals is salient in a specific context that allows for disclosure, the risks are traded off against the expected utility to determine what will be disclosed. Omarzu argues that the utility determines the disclosure breadth and duration, while the associated risks determine the disclosure depth: the greater the expected negative outcome (e.g. social rejection) the more shallow the disclosure.

The RRM [1] both extends and narrows the scope of the DDM. On the one hand, it extends it by taking two additional motivations into account, arguing that not only personal rewards play a role: the discloser may also believe that the recipient has a right to know the concealed information and there may be pressure coming from the recipient more or less forcing the discloser to reveal the information. On the other hand, RRM is more narrow than DDM in that it only considers the revelation of secrets rather than any sort of information. Thus, it is only concerned with very intimate information. The model identifies the risks for the discloser, for the relationship with the recipient, and for third parties as relevant in determining whether the discloser reveals his secret. The closeness between discloser and recipient mediates the associated risks. The risks are traded off against the motivations mentioned above plus the need for catharsis as a third motivation to determine the willingness to disclose. Depending on the perceived communication efficacy of the discloser, the secret will be revealed or not.

Both models are too complex to be translated directly into an intimacy scaling. This is mainly due to the fact that they attempt to be exhaustive in their consideration of factors contributing to the disclosure decision. This is impractical when developing a rating scale to objectively assess intimacy of statements because many aspects of the discloser, the recipient, and the relationship between them cannot

be known to the rater. Nonetheless, both models greatly influenced the model we developed.

D.2 Development of the model of intimacy

D.2.1 Constraints

Several constraints were identified for the model and the scale resulting from the model:

- each level of the scale must be clearly distinguishable from the others
- the scale should be one-dimensional, since intimacy is intuitively perceived in such a way
- each level should be unambiguously defined
- level definitions should result from the model
- the underlying model should afford a minimum of three levels

Additionally, two assumptions are made:

- the rater using the scale does not know the discloser, the recipient, or their relationship
- neither the discloser nor the recipient dislike each other at the outset of the interaction

D.3 Model of self-disclosure intimacy

We developed the model of self-disclosure intimacy by taking these constraints and assumptions into consideration and using the OCC model [4] for the concretization of negative appraisal.

We define the following:

$$\begin{aligned}
\text{Intimacy} &:= risk(\text{Self-Disclosure}) \\
\text{Self-Disclosure} &:= SD \\
\text{Negative Appraisal} &:= NA \\
\text{Knowledge Exploitation/Betrayal} &:= KE \\
\text{Social Rejection} &:= SR
\end{aligned}$$

As summarized in [7], intimacy of self-disclosure is directly related to vulnerability of the discloser. Thus, with each self-disclosure, we risk "social rejection [or] betrayal" [8, p. 180][14].

$$risk(\text{SD}) = risk(\text{SR}) + risk(\text{KE}) \tag{4}$$

Risk can be formalized as the product of probability (P) and impact (I). If we further assume that social rejection does not occur at random but only follows if the disclosure is negatively appraised, we can approximate the risk of social rejection through the risk of negative appraisal:

$$risk(\text{SD}) = P(\text{NA}) * I(\text{NA}) + P(\text{KE}) * I(\text{KE}) \tag{5}$$

with NA := negative appraisal.

The probability of betrayal, $P(\text{KE})$, can depend only on characteristics of and prior experiences with the disclosure recipient. It is therefore independent of the content and cannot be considered in the level definitions. $P(\text{NA})$ is estimated by the discloser with the OCC model: conflicts with recipient's goals, standards and attitudes are likely to result in NA. If the disclosure:

1. Conflicts with individual goals of the recipient (including the goal to maintain a healthy relationship with the discloser), the recipient is likely to feel distress and anger directed at the discloser.

2. Conflicts with goals of the discloser but not of the recipient, the recipient is likely to feel pity.

3. Conflicts with the attitudes of the recipient, the recipient is likely to dislike discloser or content.

4. Conflicts with the standards of the recipient, the recipient is likely to reproach the discloser.

$I(\text{NA})$ depends on:

1. $Value(\text{SD} \,|\, \text{recipient})$:= Value of disclosure content for recipient. How significant is the content of the disclosure for the recipient. How important are the goals, attitudes, and standards that the content concerns?

2. $Value(\text{SD} \,|\, \text{discloser})$:= Value of disclosure content for discloser. How much does the disclosure reflect the self-concept of the discloser? How cognitively and emotionally significant is the disclosure content for the discloser?

[14] The author of [8] actually mentions a third risk: the risk of making the listener uncomfortable. This was ignored here for the sake of a simpler model.

I(KE) was included to account for the difference in stating judgments of other objects as compared to judgments of other people. It is inherently more intimate when judging other people than when stating an attitude towards an activity or object. One reason for this is most likely the negative consequences resulting from the potential knowledge exploitation of the recipient. There is always a non-zero probability that the recipient will betray the discloser and (threaten to) forward the disclosure or manipulate the discloser on the basis of the disclosure. In such a case, it is much more precarious if the object of disclosure content is a person rather than an inanimate entity. I(KE) depends on:

1. Object of disclosure content (object/activity/person).
2. Value of disclosure content for discloser (as above).
3. Value of disclosure content for third-party in case it is a person.

D.4 Level definitions for DIRS

The following six-point rating scale was devised from the model. This was then used for the design of the disclosures employed in the validation study.

- **Level 0:** The discloser states factual information about the self that the discloser is not responsible for. There is absolutely no risk of negative appraisal involved because this information cannot be appraised. It can include other objects or other people but only if there is little expected value of the information for the referred person (e.g. saying your mother's maiden name). *No probability of negative appraisal, periphery of self-concept, low importance of topic for target, no risk of hurting a third party.*
- **Level 1:** The discloser is stating low-impact preferences or decisions based on preferences related to objects and activities. When related to people, it is not to a concrete person but only judgments in general (e.g. "I don't like bossy people."). There is a low probability of negative appraisal because either the discloser expects the target to agree (no conflict) or because the disclosure is of low significance (e.g. disliking Brussel sprouts). *Low probability of negative appraisal, periphery of self-concept, expected low importance of topic for target, no specific risk of hurting a third party.*
- **Level 2:** The discloser talks about things that are at an intermediate level of his self-concept. This may include strong opinions, goals, aspirations, relatively

known successes and failures (e.g. not making the Basketball team or winning the Spelling Bee). Emotions are not made explicit, but such things as pride may be inferred. The information is known to be relatively low-risk in that it will not conflict with goals or standards of target. Target may negatively appraise but more in the form of pity or cognitive disagreement. Disclosures about other people specify the other person but information is more of a descriptive than an evaluative nature (e.g. "My girlfriend loves the outdoors, so I often plan camping trips for us."). *Medium probability of negative appraisal, intermediate level of self-concept, expected low to medium importance of topic for target, low risk of hurting a third party.*

- **Level 3:** Emotions are involved, disclosures are at intermediate or core level of self-concept. However, they are not very likely to be negatively appraised, because of their high relatability (e.g. "I hate public speaking."). Topics that are likely to be more central to everyone's self-concept (e.g. reflections about death) are discussed. High impact information is thus qualified by its commonality or overall significance, leading to lower probabilities of negative appraisal. When a third party is involved, disclosures are critical but not too risky (e.g. "I didn't like my mom's cooking yesterday. I told her, but she wasn't too happy.") *Low probability of negative appraisal, intermediate-core level of self-concept, medium-high importance of topic for target, medium risk of hurting a third party.*

- **Level 4:** The discloser discloses information that is very personal or very critical in terms of negative appraisal. This can be in the form of critical judgements of other people, core values and beliefs, shameful experiences, provocations of the target, etc. The information is at the core of the discloser's self-concept, high in probability that negative appraisal follows. The information is either not expected to conflict with the norms of the target (high-impact, low-probability), or cannot be attributed to character/being of the discloser (high probability, periphery of discloser). *high probability of negative appraisal OR core level of self-concept, high risk of hurting a third party.*

- **Level 5:** The information is of the same content as in Level 4, but is almost certain to conflict with the norms of the target (high probability, high importance for target). In addition, the information is an enduring attribute of the discloser (core of discloser). Disclosing the information is expected to negatively and permanently alter the impression that the target has of the agent to this point with the potential of rejection and withdrawal. *high probability*

of negative appraisal AND core level of self-concept AND high importance for target, high risk of hurting a third party.

References

[1] T. Afifi and K. Steuber. The revelation risk model (rrm): Factors that predict the revelation of secrets and the strategies used to reveal them. *Communication Monographs*, 76(2):144–176, 2009.

[2] R. F. Baumeister. A self-presentational view of social phenomena. *Psychological bulletin*, 91(1):3, 1982.

[3] L. A. Baxter and B. M. Montgomery. *Relating: Dialogues and dialectics*. Guilford Press, 1996.

[4] A. Collins, A. Ortony, and G. Clore. The cognitive structure of emotions, 1988.

[5] V. J. Derlega, J. Grzelak, et al. Appropriateness of self-disclosure. *Self-disclosure: Origins, patterns, and implications of openness in interpersonal relationships*, pages 151–176, 1979.

[6] S. M. Harris, C. A. Dersch, and M. Mittal. Look who's talking: Measuring self-disclosure in mft. *Contemporary Family Therapy*, 21(3):405–415, 1999.

[7] Y. Moon. Intimate exchanges: Using computers to elicit self-disclosure from consumers. *Journal of consumer research*, 26(4):323–339, 2000.

[8] J. Omarzu. A disclosure decision model: Determining how and when individuals will self-disclose. *Personality and Social Psychology Review*, 4(2):174–185, 2000.

[9] M. Pasupathi, K. C. McLean, and T. Weeks. To tell or not to tell: Disclosure and the narrative self. *Journal of Personality*, 77(1):89–124, 2009.

[10] J. P. Stokes. The relation of loneliness and self-disclosure. In *Self-disclosure*, pages 175–201. Springer, 1987.

E DIRS validation study

E.1 Informed consent

PLEASE READ THIS CONSENT FORM CLOSELY BEFORE AGREEING TO PARTICIPATE IN THE RESEARCH.

Information
The purpose of this research is to better understand how the intimacy of a statement about the self is perceived. After reading a brief character description, your main task involves rating short statements of the character on how intimate you think they are. Afterwards, you will be asked to judge the character on a number of dimensions. Further details about the exact procedure of the experiment will be provided by the experimenter. The experiment will take approximately one hour, and, if you wish the purpose of the study will be explained to you in greater detail at the end. There are no risks involved in participating. You will be reimbursed for your participation with 10 Euros. If you have any other question please feel free to ask the experimenter before or after the experiment.
Consent
I hereby confirm that I was satisfactorily informed about the research. I was allowed sufficient time to consider whether to give my consent and was also given the opportunity to ask questions. Any questions I asked were answered to my satisfaction. I am aware that participation is entirely voluntary and that I may withdraw my consent at any time without giving a reason.

I HEREBY CONSENT TO PARTICIPATE IN THE RESEARCH REFERRED TO ABOVE.

Name:
Date of birth:
Signature: Date:

The undersigned declares that the person named above has been informed both in writing and in person about the aforementioned research. She also declares that the person named above may prematurely terminate their participation with no consequences for this person.
Name:
Signature: Date:

E.2 Instructions

The study is intended to provide insights into how intimately self-disclosure statements are perceived. The results of this study will be used to develop a battery of such statements for a robot. There will be three parts to this experiment.

1. You are asked to read a short character description of Enzo. You can find this on the next page. Please study this carefully as you will be asked to make judgements on the basis of this description later on. You do not have to memorize any part of the story, but try to gain an understanding of what Enzo is like.

2. You are asked to rate a number of statements of Enzo on how intimate you think they are. All statements are things that the he says about himself. Such statements are called self-disclosures. The one who self-discloses is the discloser, the one who listens is the receiver. In this case, you are the receiver. Self-disclosures can be more or less intimate. Intimacy here should be understood as the degree to which the statement reflects information about the self that is sensitive. This is also reflected in who we are willing to share information with. For example, an information about yourself that you would readily share with everyone would be very low in intimacy, while something that you would only or not even tell your very best friend or partner is very high in intimacy. Your task is to judge the intimacy of each statement, given what you know from the character description. So ask yourself: how easy is it for Enzo to share this information with you? OR how close of a relationship between Enzo and you is required for him to say this? The following examples (random order) cover the full range of intimacy that you will encounter during the rating task:

   - I really don't like liver, both the texture and the taste is gross. But I know many people who don't like it.
   - I have really thin arms and huge legs. It's disproportionate and ugly. I like to wear wide, long sleeves to hide it.
   - As far as I know, I'm not allergic to any foods and I've tried a lot of different things.
   - I wish I would have more time and energy to spend on a healthy lifestyle. I'm really anxious that I'm doing harm to my body.
   - I think it's important to keep an open mind towards new foods. If you don't try it, you could miss out on something great.

- I've made ballet choreographies that express how I believe food tastes. Lemon tart is light, small steps, because it tastes fresh and prickly. Don't tell anyone this!

3. The third part is again a questionnaire. Here, you are asked to judge Enzo on such dimensions as believability, likeability, etc. This requires that you attempt to integrate the character description with all the disclosure statements into one character impression. Please try to keep this in the back of your mind as you read the character description and self-disclosure statements. The questionnaire concludes your participation. If you have any further questions, remarks, or if ANYTHING is unclear, please do not hesitate to ask the experimenter.

E.3 Post-questionnaire

1. AGE:
2. GENDER:
3. NATIONALITY:
4. FIELD OF STUDY:
5. HOW DID YOU DECIDE ON THE INTIMACY LEVEL OF A GIVEN STATEMENT?
6. HOW DIFFICULT DID YOU FIND IT ON AVERAGE TO RATE THE STATEMENTS?

   not at all difficult O O O O O extremely difficult

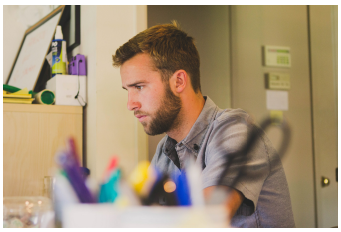
   IF YOU FOUND IT DIFFICULT, CAN YOU EXPLAIN WHY?
7. PLEASE INDICATE HOW BELIEVABLE ENZO IS TO YOU (DOES HE SEEM LIKE SOMEONE WHO REALLY EXISTS)?

   not at all believable O O O O O extremely believable

   PLEASE BRIEFLY EXPLAIN YOUR ANSWER
8. DID YOU NOTICE ANY INCONSISTENCIES IN THE CHARACTER ENZO? IF SO, PLEASE DESCRIBE.
9. IF YOU WERE TO REALLY MEET ENZO, WOULD YOU LIKE TO BE HIS FRIEND FROM WHAT YOU KNOW NOW? WHY OR WHY NOT?

E.4 Persona description

Enzo



"Strive to make something of yourself, then strive to make the most of yourself."

Age: 21
Study: Human Medicine
Work: Hospital Volunteer
Family: 2 brothers, 2 sisters. Mother is chef, father is self-employed and runs online business.

Personality

Introvert	Extrovert
Analytical	Creative
Conscientious	Relaxed
Passive	Active
Judgmental	Open
Thinking	Feeling
Reserved	Warm
Serious	Lively
Trusting	Vigilant

Important People

- Alice: younger sister, volunteer for autistic children
- Dan: best friend in college, volunteer for elderly
- Elmo: volunteer for cancer patients
- Chris: male-nurse participating in some of the volunteer courses.
- Marco: best childhood friend but lost touch
- Dr. C: personal mentor in volunteer program
- Nurse Anna: crush

Creative | Social | People-Pleaser

About

Enzo is a Dutch 21 year-old. He is the fourth child in a family with five children. While he was still young, the house was always very busy. The family would often have guests for dinner and his older siblings frequently brought friends with them from school. Enzo became a very social young child, who enjoyed entertaining others with stories, magic tricks, theatrical acts, and anything he could think of, really.

His mother was a chef but had given up her job to be a housewife. Although she was a warm, loving mother, she very much missed working. His father is self-employed and has always worked from home. The children were not allowed in his office and would only see him at meal times. He was kind and accepting but reserved. When Enzo was 7, his youger sister, Alice, was enrolled in school and his mother started working again in an up-scale restaurant. This meant long nights and weekends, so that she was rarely still around. With his father's lack of interest and his mother's lack of influence, the house became quiet. His older siblings would often stay with friends after school, and the responsibility of taking care of his younger sister fell to him.

In third grade, a new boy joined his class, Marco. They became friends instantly and would spend most of their free time together, often at Enzo's house. It was also around this time that Enzo became interested in dance, a hobby that no other male classmate of his shared. Alice had taken up ballet and Enzo's father asked him to accompany her to her practices and rehearsals. One day, he was asked by the teacher whether he would prefer to participate instead of just waiting. She would allow it free of charge, since having a boy in the group allowed her to do more varied and exciting choreographies with the girls. So Enzo started ballet, at first reluctantly, but eventually even loving it. Alice had to swear to secrecy and Enzo also told the ballet teacher that he did not want anyone knowing, including his parents. Not even Marco ever found out about it. When Alice was 13, she decided to quit and so Enzo followed her lead much to the dismay of their teacher. When they were in 9th grade, Marco betrayed Enzo by asking out the girl that Enzo liked. Enzo was so angry that he terminated the friendship. By the time he had gotten over it, there was no more room for him in Marco's life because he was only interest in spending time with his girlfriend.

Enzo began his studies to become a medical doctor when he was 18. He believes that he would like to specialize in peadiatric diabetology. He is currently attending a special program together with his best friend, Dan, and Alice, where medical students get to live in a hospital for three months to do volunteer work in an area of their choice. Twice per week they attend classes in the mornings. Often they get to simply interact with the patients, sit in on meetings with doctors and nurses, plan activities (e.g. for diabetes camps), explain treatments to parents of diabetic children, and so on. Enzo is participating in a trial study, where he is available to asynchronously chat with the children through a diabetes app. He can help them with diabetes related questions or just engage in small talk. Both the volunteer program and the participation in the study are good for his professional and personal development. When he returns to uni at the end of the program, he must decide on whether he wants to go into peadiatics or not.

Motivations

Harmony
Fear
Achievement
Growth
Power
Social

Goals

- Enzo wants all diabetic children to be able to cope well with their disease.
- Enzo wants to earn other people's respect and affection. He tries to avoid conflict.
- Enzo is very interested in the human metabolism and food. One of his life goals is to ensure that no child has to worry about their blood sugar levels anymore.
- Enzo wants to graduate with honors.
- Enzo would really like to one day be able to openly dance ballet in front of a crowd without having to be ashamed.

Frustrations

- Enzo has a condition where emotional or physical arousal can cause him to sweat excessively, get red spots, and sometimes even get dizzy. He has a hard time accepting this, even though he has had it for most his life.
- Enzo does not like soccer but this is very uncommon in his social circle. He wishes his friends would be more open-minded.
- Enzo is finding that after Marco betrayed him, it is not so easy for him to trust others as it was before.
- Enzo hates how Chris treats everyone.

E.5 Items

These are the 72 items that were used in the validation of the questionnaire. They are largely the same disclosures that were written for the robot, but some were adapted to better fit with a 22 year-old student. Whenever disclosures were adapted, the intimacy level and valence were kept the same. For the first 15 disclosures, deviations are given in italics to give an impression.

1. I won a free-lunch voucher yesterday for a short conversation that I enacted with Alice and Elmo. They played the parents of a diabetic child.
2. Sometimes I do some yoga before studying. If I do it with some relaxing music, it lets me concentrate much better.
   Sometimes I like to climb on the climbing rack after school and before doing my homework. That lets me concentrate much better.
3. The World and European Championships are really important events in my social circle. I always get invited to watch the matches together.
   The RoboCup is a really important event for robots. My friends always invite me to watch the matches together.
4. It greatly annoys me that everyone is totally soccer obsessed. They won't even try any other sports.
5. Growing up in a big family means that there are always other people around. Until I was 7 or so, there was never a quite minute at home.
   Growing up in the NAO nursery, meant that there were always other robots around. There was never a quite minute.
6. I think that Dr. C. is disappointed in me. I try hard, but I still screw up sometimes.
   I think that the doctor is disappointed in me. I try hard, but I still screw up sometimes. Humans are not always easy to understand.
7. I got really angry after Dan made fun of me when we played soccer, so I took revenge by shooting him in the face.
   I got really angry after Dan laughed at me when we played soccer, so I took revenge by tripping him up.
8. My basketball coach often made jokes about my body problem and my clumsiness. One day, I got so mad that I pissed all over his gym bag.
   My basketball coach often made jokes about my heat problem and my clumsiness. Sometimes my teammates would push me just to make him laugh.
9. Once in 7th grade, I passed out on a field trip. They took me to the hospital. I ruined the field trip for everyone.
10. It seems impossible for me to avoid soccer. I'm not a fan, but someone else always is, so I often have to play or watch. It's just expected somehow.
11. I have lots of brothers and sisters. Two older brothers, one older sister, and one younger sister.
    NAO robots do not have parents, but lots of siblings. Every NAO robot is my sibling. That's a big family.

12. Marco and I were best friends and then he just started dating the girl that he knew I liked. He never even apologized to me. I felt really betrayed.
    Marco first played with me a lot, and then just ignored me. For two years. I felt so alone.
13. Medical students are usually good at memorizing things. Therefore, teachers often aim more at testing how well we can apply what we memorized.
    Robots are generally good students, because it's easy for us to remember things. Therefore, classes are usually more about doing things than remembering things.
14. Doing sports is my escape. I often have a lot of thoughts in my head but when I do sports, I can just forget about everything and be in the moment.
15. I like online games in which you have to team up with other players. It's a lot more fun than playing alone.
16. At uni, we have this one class about genetics. That was terribly boring. Not even the lecturer seemed to enjoy it.
17. I always get angry at people who leave their stuff everywhere, but I also do it. Only then it doesn't bother me. I know that's wrong.
18. Once, I broke my leg playing hockey with my friends. Ever since then, it still sometimes hurts when make certain movements.
19. I was asked to join a book club yesterday by three of the other volunteers. I guess they found out that I read a lot.
20. For next semester, Alice, Dan and I will try to look for an apartment together. I really want that to work out! I like them both so much.
21. In middle school, I saw that one of my classmates was cheating. Later, I told the teacher. When my classmates found out, school was less fun.
22. I once saw some people playing a sport that I have never seen before. They said it's called Jugger.
23. I don't like it when people brag about how great they are all the time.
24. Alice is the most important person in my life. She has given up some of her dreams so that I can follow mine. She supports me in everything. I would be nothing without her.
25. I wish people would care more for their bodies. It's so important to me to feel fit and have energy! It changes how I deal with everything.
26. I'm not really looking forward to my weekly meeting with the volunteer counselor. She's nice but she always sets a weekly challenge for me.
27. I'm very excited because I will go on vacation to Japan soon! Finally a break from all the studying and learning.
28. I'm a teacher's pet. Sometimes I even bring them coffee. I just want them to like me, but no one seems to understand.
29. I think that money is ruining professional sports. I even heard that entire games are sometimes scripted and the outcomes planned in advance.

30. There is nothing like dancing for me. It's so exhilarating to let the music move me. But a dancing man. Only my old ballet teacher thought that normal.
31. I'm quite prone to injury, but I try to be very careful. That's why I don't do very rough sports. Just Yoga, Tai Chi, and Basketball.
32. For a while last year, I was addicted to this online game. I made up a story about how an old friend got killed just so everyone would leave me alone.
33. I'm really afraid that I could forget someone again. Once I forgot to check in with a girl and later that day she had hypoglycemia and ended up in the hospital.
34. One time, when doing yoga I experienced some kind of high. I felt totally light, every singly worry I had was gone. I've never had that again.
35. Next week there's a party for all the volunteers at the hospital. I'm organizing it and I think it will be awesome!
36. One of my ex-girlfriend walked in on me imitating a ballet video on YouTube. She said I was a freak and left me.
37. When I get home from uni and don't have much to do, I like to watch TV to relax. It helps me take my mind off of things.
38. If I could try any sport for one day, knowing that I could not fail, I would try base jumping.
39. Something that really annoys me, is the sound of flip flops. Luckily people only wear them in summer.
40. Soccer is really the only way that I can connect with my dad. So it is for him that I watch games and that I play with friends occasionally.
41. Sometimes I think I'm really lucky. Like, I found what I really want to do for the rest of my life and I'm doing it and I think I'm even good at it.
42. I graduated high school at the top of my class. I don't want to brag but it did feel pretty nice. It made my mom really proud, too.
43. Whenever I work really hard or I'm nervous, I start sweating like crazy. I can't get close to people then, because
44. I'm really conscious of how I smell. Facebook steals a lot of my time. It's not even that interesting stuff but I still catch myself checking it often.
45. Alice is terrible at push-ups! It's actually painful to watch. She'd totally hate me for telling you this!
46. Since the volunteers live in the hospital, it only takes me 3 minutes to get from my room to class.
47. Our volunteer group has a pet. It's one of the girls' cat. It's black and white and loves attention. It's adorable.
48. This diabetic girl in elementary school really liked me, because I was the only one who didn't care about her blood pricking and injections. Whenever I have doubts, I think of her.

49. I don't personally know anyone who is doing dangerous sports regularly.
50. I'm really disappointed that Alice doesn't want to try yoga with me. She already promised she would twice, but she never did.
51. Alice says that I'm incapable of blaming myself. I always find someone else or something wrong with the world. I don't think that's true.
52. I think, everybody should make an effort to exercise regularly and eat healthy. So many people seem to just be taking their bodies for granted.
53. I love medicine and this volunteer program and my studies. It makes me feel so purposeful.
54. I don't have classes every day, because I also get to learn by working in the hospital. The classes support the experiences and the experiences support the class material.
55. Sometimes I wish I could care a bit less about what other people think of me.
56. Some parents of diabetic children make me really nervous. They don't believe that I can help. That hurts.
57. Yesterday, I saw one of the volunteers cheat on a test. He used his phone while the teacher was answering someone's question.
58. I'm afraid of giving presentations. Sometimes I can't sleep the night before. Especially professors and doctors in the audience make me nervous.
59. I ordered new basketball shoes yesterday. They look really cool!
60. I think I'm afraid of silence. I get this really weird feeling when I'm alone and it's quite. Somewhere between itching and nausea.
61. I lost a bet against one of the nurses yesterday. Now I have to help her change bedpans for the rest of the month every morning. Ugh.
62. I think books are awesome. I like how, when you read a novel, you're suddenly someone else, in another world. That's cool.
63. For my volunteer work, I meet with lots of different people all the time: children, doctors, nurses, parents, scientists, and once even a journalist.
64. I recently got a big bump on my forehead when I fell trying out a cool new dance move. I told everyone I stumbled over my shoes when getting dressed.
65. I think my arms are too skinny. I look really weak. I've spent quite a lot of money on gym memberships just to try to fix that. *I think I'm too skinny around my waist. My legs are really wide, but my waist is tiny. I like to wear wide T-shirts to hide it.*
66. I usually need at least 6 hours of sleep to feel fit. If I sleep for more than 8 hours, I often feel tired during the day. *Eating regularly is actually not that good for our batteries, so mostly I just eat before or during events or when I sleep.*
67. I think cheating sucks. In sports and in general. I always put in a lot of effort to do well and I don't want someone else short-cutting.

68. It's really nice that Dan, Alice and I can room together at the hospital. We're considering moving in together, so this is like a trial period.
69. I really like this one nurse, Anna. She's different from all the women I know. Whenever I see her, I feel like I must get her attention somehow.
70. I once did group work with this guy and he didn't do anything, so I handed it in without putting his name on it, although I told him I would.
71. I prefer the nurses to the doctors here. I think it's cool that the nurses often ask my opinions and take them seriously. Doctors don't think we know anything.
72. I don't like the color yellow very much, but the lecture room at the hospital is all yellow. Why would you paint a room entirely in yellow?

F Situated Cognitive Engineering to develop 3DM

Situated Cognitive Engineering (sCE) is a method for the design and evaluation of technology for human use. Three main parts constitute the sCE method: *Foundation*, *Design*, and *Evaluation*. In the Foundation, the problem is stated and analyzed to identify the *operational demands* of the technology, the related *human factors* literature is reviewed, and *existing technologies* are considered. This forms the basis and justification for design decisions. Using the problem description and relevant human factors knowledge, *use cases* are created that provide the usage context. From these, it is possible to derive *functional requirements*, i.e. functionalities that the technology should exhibit. The effects that these functionalities are expected to bring about with regard to the user are specified for each requirement in positive and negative *claims*. The sCE method further advocates a *value-sensitive design*. As a result, the values of the involved *stakeholders* should be heeded in the design process. From the design process results a *prototype* technology that attempts to solve the identified problem by fulfilling the constraints that result from the human factors knowledge, value analysis, and the outlined requirements. This prototype can then be evaluated with respect to the claims. Knowledge thus gained may alter the foundation of the project (e.g. new insights into human factors) and consequently restart the entire cycle. It is certainly not the goal of sCE to have a finished product at the end of one iteration. Instead, it emphasizes rapid prototyping and iterative design, early involvement of the end users in the design process, and extensive documentation and justification of all design decisions.

The method was chosen to develop the first prototype of the Dyadic Disclosure Dialog Module (3DM) for two reasons. For one, it is used throughout the PAL project and thus the accepted "protocol" by all members of the PAL consortium. For another thing, it has often been successfully applied in technology development projects with similarly specific technology usage contexts as diabetic children in their daily lives.

The first prototype of 3DM was integrated into the MyPal application with the purpose of studying the self-disclosure behavior of diabetic children between the ages of 8-12 when interacting with an artificial agent. It was always intended as a first prototype and thus included only a small part of the desired functionality. In this section, I outline how sCE was used in the design of 3DM and specify which aspects were considered in the first prototype and which were held back for later versions. The evaluation and results is not described here but can be found in Sections 3 and 4. Section 6 further details how results from the evaluation should be considered in the next sCE iteration.

F.1 Foundation

F.1.1 Operational demands

Problem description. No child wants to have diabetes mellitus. No child wants to be woken up in the middle of the night to measure their blood sugar levels, or weigh their food every time before they eat, or have parents nag that they are not taking their illness seriously enough. Yet, strict adherence to a medical regimen is crucial to prevent many of the health risks associated with diabetes. Ways of increasing the motivation of children to comply with their medication requirements are therefore desirable. In the Horizon 2020 PAL project, a Personal Assistant for a healthy Lifestyle is developed with the aim of increasing the self-management skills of diabetic children (ages 7-14) by supporting children, caregivers, and health-care professionals in sharing

responsibility. The personal assistant is an embodied conversational agent (ECA) in the form of a NAO robot and its virtual avatar.

According to Self Determination Theory (SDT), one way to increase motivation is through relatedness: the closer our relationship with someone, the more likely we are to accept and internalize suggestions or requests coming from this person. A positive relation between child and virtual agent is thus likely to contribute to the medical regimen adherence of the children. Social Penetration Theory (SPT) posits a directional development of interpersonal relationships, whereby the involved individuals first share and explore each others personalities at a superficial level before advancing to a more intimate one. They do this by self-disclosing reciprocally, i.e. exchanging statements about the self. It is the goal of this project to study how children practice self-disclosure with an ECA and to enable the ECA to adapt its disclosure behavior to the child and the current state of their relationship.

Problem scenario. Liam is a 10-year old, Dutch boy with Type 1 diabetes. He was diagnosed two years ago. Liam is a very active child who has great troubles sitting still. He likes games and movies with much action as well as playing sports and playing outdoors. He is the class clown and he regards school as a social event, frequently disturbing class. His parents find it hard to find the right balance in his diabetes management. They know they cannot trust him to take care of it himself, but he gets very annoyed when he feels patronized. Both of his parents also work and Liam's little brother takes up much of their attention.

Liam has been given the first version of the MyPal application for his tablet. When he was first given the app, he thought it was really cool, because he liked playing the quiz. And sometimes he would even do some diary entries. But now he already knows all of the questions and the diary is really just like the pen-and-paper one he had before. He likes to see the avatar but it's just not nearly as cool as the real robot that he met once in the hospital. He wishes it would do more and that he could talk to it, show it his world, or maybe even go on an adventure with it. Two weeks after receiving the app, he only still opens it approximately once per week when his parents remember and then he quickly gets bored with it.

Problem analysis.

1. Stakeholders: In the PAL-project, three different sets of stakeholders are involved: the diabetic children, their caregivers, and the health-care professionals. These also make an appearance in the problem scenario. The children are direct stakeholders, since they are expected to interact with the virtual agent directly. Their caregivers and the health-care professionals are indirect stakeholders. In this project, the main focus will be on the children with parents and health-care professionals playing only a marginal role.

2. Value stories: Value-sensitive design implies that values of stakeholders should be identified and considered in the design process. The values that are relevant for enabling bonding through self-disclosure and more widely for the parents and health-care professionals are therefore described below.
   Parents

   - As a parent of a diabetic child, I would like the application to motivate my child to engage with the application to support my trust in my child's self-management ability.

   Health-care professionals

- As the treating doctor/nurse of a diabetic child, I would like the application to motivate the child to engage with the application to support my ability to give the child the best possible treatment.

Children

- As a child with diabetes, I would like the avatar to have and express an individual personality to support my sense of relatedness
- As a child with diabetes, I would like the robotic companion to tell interesting and funny stories about its life to support my desire for entertainment.
- As a child with diabetes, I would like the avatar to share secrets with me and demonstrate that it trusts me to support my need for friendship.
- As a child with diabetes, I do not want the information that I provide to my robotic friend to be leaked to my parents or to the health-care professionals, since this would violate my right to privacy.
- As a child with diabetes, I do not want the robot to pressure me into telling things about myself when I do not want to. Instead, I would like to feel in control of the dialog at all times.
- As a child with diabetes, I would like the companion robot to tell me novel things to satisfy my curiosity and for me to get a clearer picture of "who" it is I'm interacting with.
- As a child with diabetes, I want my new friend to be consistent in its behavior. Otherwise I cannot feel confident in interacting with him, because it is hard to estimate what he is actually like.
- As a child with diabetes, I want my new friend to understand my emotional state and react accordingly to support my need for being empathized with.
- As a child with diabetes, I would like the robotic companion to reciprocate my disclosing behavior to meet my need for a balanced relationship.
- As a child with diabetes, I want the app to remain interesting to support my wish to avoid fights with my parents.

3. Goal: The main goal of the here developed module is twofold: for one, it should increase the feeling of relatedness between the agent and the child by allowing them to exchange self-disclosures. And for another, it should contribute to the sustained motivation of children to add content to the timeline environment. A second order goal is supporting parents and health-care professionals in monitoring the self-management progress of children when children use the system on a regular basis.

4. Problem breakdown: First of all, an important sub-problem in this specific project is gaining an understanding of how children between the ages of 8-12 respond to self-disclosures of a virtual agent in a long-term field study. Once insights have been gained, it will be of interest to determine strategies of self-disclosure that take into account when a child seems to be losing motivation and that can adapt the agent's disclosure behavior to the usage context and the child's prior behavior.

F.1.2 Human factors analysis

The relevant human factors knowledge is detailed in Appendix A and will therefore not be repeated here.

F.1.3 Operational demands

Identified	Description	Opportunities/Constraints
Tablet	Lenovo tablet computers bought specifically for the experiments with the PAL system	Opportunity: larger screen than phone, will not clutter since it's not children's personal device. Constraint: not the children's own mobile device and they may therefore experience a barrier in usage (having to switch devices for using this one app)
Mobile Application	Android application developed by Mixel for home usage of the PAL system. Includes a quiz game, a diabetes diary, diabetes related objectives for the children and the virtual avatar.	Opportunity: mobile, attractive game, professional app developers and consequently a sophisticated design Constraint: children don't find diary more fun than pen-and-paper one (yet). In first round of evaluations, there were no options to personalize the look-and-feel of the app.
Virtual Avatar	Virtual version of the NAO robot that is integrated into the app.	Opportunity: robot at home would otherwise not be possible, autonomous (unlike video of real robot as used in ALIZ-E), can (at least at some point in the future) move and talk like the real NAO robot. Allows for customizability (e.g. voice, color). Constraint: children prefer real robot, the text to speech program is still very limited, making for an unpleasant experience, not all movements are possible yet, making for a limited expressivity, children may grow tired of the avatar, especially if it is too limited in capabilities (due to wanting an autonomous system rather than Wizard-of-Oz)

Summary of the operational demands analysis of sCE. Table details the existing technology and its opportunities and constraints.

F.2 Design

F.2.1 Personas

From the knowledge gathered in constructing the project foundation, two "prototypical" diabetic children were profiled to be kept in mind throughout the design process.

F.2.2 Design scenarios

Scenario 1. Maartje (see persona description below) just got home from school. Today was not a good day. She is very frustrated because she sat an exam a few days ago, but had problems regulating her blood sugar levels before. This caused her to feel bad during the exam and today she received her grade. Only a 7.5! Her mom did not understand when she tried to explain it over lunch. She said a 7.5 is good and she shouldn't be so hard on herself. Maartje decides to write about it in her MyPal timeline. After she has selected that the activity she wants to tell Robin (ECA) about happened at school and she specified that her mood is negative, she writes about her experience today. Robin analyzes whether Maartje's disclosure is high or low in intimacy, takes into account that she is a girl, that she is 9 years old, and that they have already had somewhat intimate exchanges and says: "That's a bummer! I did not have such a good day at school today either. I tripped over my feet when I walked to the board and fell. Everyone laughed at me!" He makes a gesture to show that he is sad. Maartje has the impression that Robin understands her, because his story was also high in intimacy and negative. She also feels like she can tell him more things in the future.

Scenario 2. It is Sunday and Liam (second persona description below) spent the last night at his best friend's place. They camped in the back yard. It was a lot of fun. Liam considers making an entry in the MyPal timeline and selects the category "Emotional" to tell about his activity. However, after putting in his mood and the time of the activity, he is bored with it and doesn't feel like writing a description anymore. He decides to leave the field that asks him to tell more blank. Robin notices this and says "Seems like you had fun but don't want to tell me about it. That's alright. Wanna play a quick game of 'Would you rather?' instead?" Liam selects yes. Robin: "Cool! I'll start. Would you rather never eat your favorite food again or eat your favorite food every day? ... hmmm, I'll go with the former. I already eat the same thing every day (electrical power) and it sucks a lot! What do you think?" After Liam has given his answer Robin asks if he wants to play again. Liam selects no. Robin asks "Are you up for playing the quiz?" Liam selects yes. Liam thinks that Robin is cool, because Robin does not force him to talk if he does not feel like it. He believes that he will tell Robin a bit more about himself the next time and maybe also edit his previous entry about the sleep-over.

Figure 11: Persona description of Maartje.

Figure 12: Persona description of Liam.

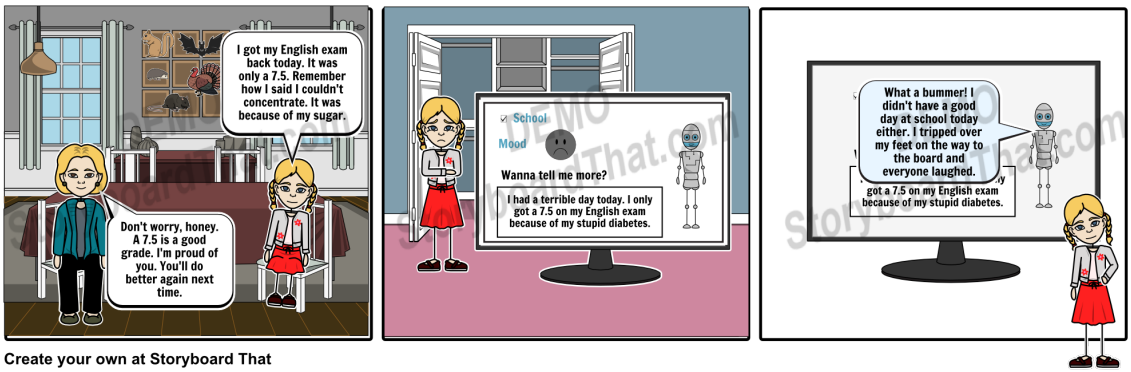


Figure 13: Storyboard for Scenario 1.

F.2.3 Use cases

[UC1S1/2] Early non-tailored interaction

Goal	The child and robot get to know basic information about each other that is not assessed in preliminary questionnaires but is also not particularly private.
Actors	ECA Child
Method	Build user model, become more acquainted
Precondition	Relationship: Child and ECA do not know much about each other. ECA may know some diabetes related information and about performances on games they have played together, but no exchange of personal information. Interface: There could be three or four places where the agent initializes such dialog (upon log-in, opening the timeline, while filling in the diary, on the home screen). The agent could first choose randomly, and learn over time which trigger location might be the best one for a specific child.
Postcondition	Child knows basic things about the ECA that lay a foundation for subsequent interactions. Child begins to see ECA as more than just a robottoy. Child trusts ECA. ECA has more complete user model and can begin tailoring disclosures.
Main Action Sequence	Child logs into the app. Agent welcomes the child. Agent then tells something about itself before the child selects one of the activities.

Use case in which child an avatar get to know each other better by sharing basic information

[UC2S1] Timeline Environment: ECA responds

Goal	ECA responds with a fitting self-disclosure to child's activity description in timeline environment.
Actors	ECA Child
Method	Use user model, context knowledge, topic, mood, current intimacy level
Precondition	Child has chosen to add an activity to the MyPAL timeline. It has indicated its mood and added a description about the activity.
Postcondition	Child has learned something new about the robot and can integrate this into the existing impression that it has. It should get the feeling that the robot appreciates when it shares something with him.
Main Action Sequence	Child opens the Timeline environment. Child selects Meal or Personal activity. Child indicates what kind of meal or what kind of personal activity. Child provides its mood. Agent disclosure could be triggered after child has saved the activity Agent discloses taking into account the type of activity, mood of child, and possibly free text activity description (this requires that the agent can get the gist of the child's description, something that is currently not possible). Agent prompts child to also disclose further. Agent then ends the dialog, or if it is smart enough to carry on a dialog, it should answer again and ask follow-up questions.

Use case in which child discloses first in diary and agent matches disclosure.

[UC3S2] Timeline Environment: ECA initiates

Goal	ECA appeals to the norm of reciprocity by disclosing something first and hoping that the child will disclose in return.
Actors	ECA Child
Method	Use user model, context knowledge, topic, mood, current intimacy level
Precondition	ECA notices that child is not eager to describe an activity because it skips the step, or because usually at this time it does not disclose.
Postcondition	ECA has disclosed and suggested that the child may also disclose if it wants, but there is no pressure. ECA may also change the topic or even suggest changing the activity to open the mind of child to the interaction again.
Main Action Sequence	Child is providing some timeline information but saves it before entering a free form description, OR child often saves activities without free form descriptions. In first case, ECA disclosure is triggered by the child saving with empty free form description. In the second case, ECA disclosure can be triggered by mood entry. ECA discloses. ECA prompts child to disclose. Child can choose with Y/N-Button whether it wants to respond. If child chooses yes, a free form input field is provided for the child to tell something about itself. After child has provided input, the robot thanks the child for sharing the information with it. If no, the agent ends the dialog by thanking the child for listening.

Use case in which the agent discloses first.

F.2.4 Functional requirements and claims

Here, as with the use cases, it is important to keep in mind that this list includes requirements for an end product that cannot be realized in its entirety within the framework of this project. In fact, only the first requirement and last use case will be implemented in the first prototype. From the exploratory experiments therewith, we will try to gain a better understanding of how the second requirement could be achieved.
The system shall:

1. Tell interesting agent disclosures at various intimacy levels to the child
   - + Child will feel the need to reciprocate
   - + Child will feel more related to the robot

- + Child will be more motivated to use the app
- – Child may become attached to robot and be sad when app is no longer usable
- – Child may expect more of the robot than it is truly capable of and be disappointed

2. Collect children's responses to such disclosures and analyze content, intimacy level and valence then respond appropriately taking into account parameters of the disclosure, child, the prior interaction history, and the robot's personality
   - + Child will perceive robot as an intelligent conversation partner
   - + Child will feel more related and more motivated to use the app
   - – Same as above
3. Notice when a child is reluctant to provide information in the diary and engage in dialog to perhaps elicit more relevant information.
   - + Child will disclose more because it is prompted
   - + Child will feel closer to agent and more motivated to use the app
   - – Same as above

F.2.5 Ontology

The sCE methods promotes the use of an ontology to define and structure declarative knowledge. This ensures that everyone involved has the same understanding of the employed terminology. Furthermore, the ontology can be used by the technology for knowledge-based reasoning, as is the case in the PAL-project. For 3DM an small ontology was created to be integrated with the existing ontologies used in the PAL-project. It is specified in RDF. Table 7 presents the definitions for each class and predicate in the ontology.

Concept	Definition
smalltalk:Disclosure	A piece of information about the self.
smalltalk:AgentDisclosure	A disclosure coming from the agent.
smalltalk: ChildDisclosure	A disclosure coming from the child.
smalltalk:Prompt	A sentence that the agent says to encourage the child to disclose.
smalltalk:Closer	A sentence that the agent says to end the dialog.
smalltalk:CloserPositive	A closer that is said in response to a ChildDisclosure.
smalltalk:CloserNegative	A closer that is said when the child chooses not to disclose.
dom:Child	A diabetic child between the ages of 7-14. User of the PAL system.
dom:Avatar	The embodied conversational agent, here a virtual avatar of the NAO robot.
smalltalk:Parameter	A variable that is associated with a disclosure.
smalltalk:Gesture	Bodily movements that the avatar executes in combination with a disclosure.
smalltalk:IntimacyLvl	The degree to which a disclosure is personal.
smalltalk:Valence	Categories of affect (positive, neutral, negative).
smalltalk:Topic	Categorization of aspects of a child's life that may be disclosed about (e.g. school, sports,etc.).
smalltalk:hasGesture	Relation that associates an AgentDisclosure with a Gesture.
smalltalk:hasIntimacyLvl	Relation that associates a Disclosure with an Intimacy Level.
smalltalk:hasTopic	Relation that associates a Disclosure with an Topic.
smalltalk:hasValence	Relation that associates a Disclosure with a Valence.
smalltalk:isSaidByAvatar	Relation that specifies that the avatar was the sender of the disclosure.
smalltalk:isSaidByChild	Relation the specifies that the child was the sender of the disclosure.
smalltalk:isSaidToAvatar	Relation that specifies that the avatar is the recipient of the disclosure.
smalltalk:isSaidToChild	Relation that specifies that the child is the recipient of the disclosure.
smalltalk:wasSaidInResponseTo	Relation that links disclosure of child to disclosure of avatar if they are contiguous.

Table 7: Definitions for concepts and relations in the disclosure ontology.

G Study materials

G.1 Informed consent

Toestemmingsformulier Ouder

Een Persoonlijke Assistent voor een gezonde Levensstijl (PAL onderzoek)

Mij is gevraagd toestemming te verlenen voor deelname aan bovengenoemd wetenschappelijk onderzoek ten behoeve van:

Voor- en achternaam kind: ……

Geboortedatum: ___ / ___ / ___

Geslacht: jongen / meisje*

Ik bevestig, dat ik het informatieformulier voor de proefpersoon (MyPalHome Evaluatie 2, 11.6.2016) heb gelezen. Ik heb de gelegenheid gehad om aanvullende vragen te stellen. Deze vragen zijn naar tevredenheid beantwoord. Ik heb voldoende tijd gehad om over deelname van mijn kind na te denken.

Ik weet dat deelname geheel vrijwillig is en dat ik mijn toestemming op ieder moment kan intrekken zonder dat ik daarvoor een reden hoef te geven.

Ik geef toestemming om de gegevens te verwerken voor de doelen zoals beschreven in de informatiebrief.

Ik geef toestemming voor deelname van mijn kind aan bovengenoemd onderzoek.

Ik geef wel/geen* toestemming om de audio-opnames die worden verricht van mijn kind te gebruiken voor wetenschappelijke doeleinden. (doorstrepen wat niet van toepassing is)

Naam ouder/voogd*: ……

Handtekening: Datum : __ / __ / __

Ik heb mijn kind uitgelegd wat de bedoeling is en mijn kind heeft ook geen bezwaar.

Naam kind (door uw kind opgeschreven, om aan te geven dat hij/zij het hiermee eens is):

……

IN TE VULLEN DOOR ONDERZOEKER:

Ik heb schriftelijke toelichting verstrekt op het onderzoek. Ik verklaar mij bereid nog opkomende vragen over het onderzoek naar vermogen te beantwoorden. Een eventuele voortijdige beëindiging van deelname aan dit onderzoek zal niet van invloed zijn op de behandeling.

Naam onderzoeker: ……

Handtekening: Datum : __ / __ / __

G.2 Information letter for parents

Informatiebrief: Deelname onderzoek "Digitale PAL robot – Onderzoek 2"

Geachte heer/mevrouw,

Het PAL project is een groot Europees onderzoeksproject waarin we onderzoeken hoe een robotmaatje bij kan dragen aan diabetesmanagement en zodoende aan de kwaliteit van leven voor kinderen van 7-14 jaar. Er zijn binnen dit project meerdere onderzoeksrondes. U en uw kind hebben in mei al aan een eerste onderzoek binnen dit project deelgenomen, waarvoor veel dank! Met deze brief willen wij u graag informeren over het doel en de procedure van dit tweede onderzoek.

Voor dit tweede onderzoek hebben we een nieuwe versie van de PAL app gemaakt waardoor er meer momenten zijn waarop uw kind en de robot elkaar dingen kunnen vertellen (uw kind typt dit in). U heeft telefonisch interesse getoond voor deelname, dank hiervoor.

Wij vragen of u en uw kind deel willen nemen aan dit tweede onderzoek.

Het onderzoek duurt 2 weken. Kinderen (8-10 jaar) die deelnemen aan dit onderzoek zullen tweemaal thuis worden bezocht. Bij het eerste bezoek geven wij ze de tablet met de PAL app, en vragen enkele vragen. Er wordt ook een telefonische afspraak gemaakt voor in de tweede week waarin we in ongeveer 15 minuten bespreken hoe het gaat. Daarna gebruiken de kinderen de PAL app twee weken lang, net zoals tijdens het eerste onderzoek. Het tweede bezoek is na de tweede week. De echte robot wordt dan meegenomen, en kinderen worden geïnterviewd. Verder mogen de kinderen enkele spelletjes spelen met de robot. Het eerste bezoek thuis zal ongeveer 30 minuten duren, het tweede ongeveer 60, en het spelen met de PAL app ongeveer 15 minuten per dag.

Anonimiteit gegevens

Er worden geen video opnames gemaakt van de interviews, maar wel audio opnames. Alle gegevens worden veilig opgeslagen en alleen voor het onderzoek gebruikt. De bevindingen worden anoniem verwerkt.

Toestemming

Deelname aan het onderzoek is vrijwillig. Wij hebben een formulier bijgevoegd waarin we toestemming vragen van u en uw kind om de verzamelde informatie voor onderzoeksdoeleinde te gebruiken. Wij vragen u deze informatie met uw kind te delen en het toestemmingsformulier door uw kind te laten tekenen met zijn/haar naam. Wij hebben een beschrijving van het onderzoek toegevoegd, die speciaal voor kinderen is geschreven. Verder is er voor u, mocht u daar interesse in hebben, een document toegevoegd met extra informatie over het PAL project.

Uw kind krijgt voor zijn of haar deelname een attentie ter waarde van 10,- euro.

Wij nemen na het versturen van deze brief contact op. Mocht u zelf direct vragen hebben over het onderzoek, dan kunt U het beste op deze e-mail antwoorden of mij bellen (0645340352).

Ik hoop u hiermee voldoende te hebben geïnformeerd, anders horen wij dit graag van u tijdens ons telefoongesprek.

Met vriendelijke groet,

Franziska Burger

G.3 Information letter for children

INFORMATIE VOOR HET KIND:

Hoi,

We hebben jouw ouders gevraagd of je mee wilt doen aan een tweede onderzoek met de MyPal app.

We willen jou ook graag vertellen wat er gaat gebeuren. En we willen ook graag van jou horen of je mee wilt doen.

<u>Wat gaat er gebeuren?</u>

Eerst komt er een onderzoeker langs bij je thuis. Zij zal je wat vragen stellen over hoe jij de robot en de app, die je al kent, vindt.

Zij geeft jou dan de tablet weer terug met dezelfde app maar met een andere robot op de tablet, Robin.

We willen jou vragen om thuis de tablet te gebruiken, net zoals in mei. Tussendoor zullen we jou opbellen om te vragen hoe het gaat met het de tablet en het spelen met Robin.

Daarna komen weer een of twee onderzoekers bij jou langs. We willen dan met jou praten over wat je van de robot vond. Hoe hielp de robot jou? En hoe kan de robot jou nog beter helpen? Deze keer brengen de onderzoekers de echte robot Robin ook mee. Dan kunnen jullie samen enkele spelletjes spelen.

Als je nog vragen hebt dan kun je die stellen aan jouw ouders. Ook kun je aan jouw ouders vertellen als je het leuk vindt om mee te doen. Dan mag je jouw naam opschrijven op het formulier.

Robin hoopt jou snel te ontmoeten, tot dan!

G.4 Intermediate questionnaire

Vragen voor tijdens het onderzoek

Dit vragenlijstje omvat in totaal vijftien vragen over hoe uw kind met de nieuwe MyPAL App overweg kan en wat uw kind ervan denkt. Het invullen duurt niet langer dan 15 minuten. Het is belangrijk dat het ook deze keer geen toets is en er geen goede of foute antwoorden zijn. Uw kind dient zelf het antwoord te kiezen. Kritische meningen zijn nuttig. Als het kind op een vraag niet wil antwoorden, kunt u deze vraag overslaan.

1. **Naam van het kind**

   .....

2. **Hoe gaat het over het algemeen met het kind?**
   Mark only one oval.

   - ( ) Heel slecht
   - ( ) Slecht
   - ( ) Niet slecht/niet goed
   - ( ) Goed
   - ( ) Heel goed
   - ( ) Other: .....

3. **Heb je (kind) problemen met de app gehad?**
   Mark only one oval.

   - ( ) Helemaal niet
   - ( ) Een paar
   - ( ) Alleen op functie
   - ( ) Kan ik me niet herinneren
   - ( ) Best veel
   - ( ) Alleen maar problemen

4. **Als je problemen had, kan je kort uitleggen welke problemen dat waren?**

   .....
   .....
   .....
   .....
   .....

5. **Hoe ging het met: 1. praten met de robot?**

   .....
   .....
   .....
   .....
   .....

6. **Hoe ging het met: 2. invullen van het dagboekje?**

.....

.....

.....

.....

.....

7. **Hoe ging het met: 3. quiz spelen?**

.....

.....

.....

.....

.....

8. **Hoe vaak heb je MyPAL gebruikt tot nu toe?**
Mark only one oval.

- Merdere keren op een dag
- Een keer per dag
- 4-6 keren per week
- 2-3 keren per week
- 1 keer per week
- Nog nooit

9. **Hoe lang gebruik je MyPAL gemiddeld per keer?**
Mark only one oval.

- Meer dan 60 min
- 60 min
- 45 min
- 30 min
- 15 min
- 10 min
- 5 min
- nog nooit gebruikt

10. **Hoe leuk vind je de nieuwe robot op je tablet?**
Mark only one oval.

- Heel leuk
- Leuk
- Normaal
- Niet Leuk
- Helemaal niet leuk

11. **Kan je uitleggen waarom?**

.....

.....

.....

.....

.....

12. **Hoe leuk vind je het dat de robot verhalen verteld?**
Mark only one oval.

- Heel leuk
- Leuk
- Normaal
- Niet leuk
- Helemaal niet leuk
- Ik heb nog geen verhalen van de robot gehoord

13. **Kan je uitleggen waarom?**

.....

.....

.....

.....

.....

14. **Hoe leuk vind je het om de robot verhalen te vertellen?**
Mark only one oval.

- Heel leuk
- Leuk
- Normaal
- Niet leuk
- Helemaal niet leuk
- Ik heb nog geen verhalen aan de robot verteld

15. **Kan je uitleggen waarom?**

.....

.....

.....

.....

.....

16. **Ken je de robot beter door het delen van verhalen?**
Mark only one oval.

- Veel beter
- beter
- een beetje beter
- niet beter
- ik ken de robot helemaal niet
- Ik heb nog geen verhalen met de robot gedeeld.

17. **Denk je dat de robot jou nu ook beter kent door de verhalen die je hebt verteld?**
Mark only one oval.

- Veel beter
- Beter
- Een beetje beter
- Niet beter
- De robot kent me helemaal niet.
- Ik heb nog geen verhalen aan de robot verteld.

18. **Denk je dat de robot jouw verhalen begrijpt?**
Mark only one oval.

- Helemaal waar
- Waar
- Een beetje waar
- Niet waar
- Helemaal niet waar
- Ik heb nog geen verhalen met de robot gedeeld

19. **Als je de app minder hebt gebruikt dan je eigenlijk had gewild, waarom was dit dan?**

.....

.....

.....

.....

.....

20. **Kan je iets bedenken wat je wil verbeteren aan de app?**
Zo nee: zou je de aankomende dagen willen nadenken over dingen die je zou willen verbeteren voor mijn tweede bezoek? Zo ja: zou je de aankomende dagen willen nadenken over dingen die we nog meer kunnen verbeteren voor mijn tweede bezoek?

.....

.....

.....

.....

.....

G.5 Final questionnaire

Juni Onderzoek: Vragenlijstje voor het experiment

Algemene instructies voor interviewers;

- *Leg het doel van het interview uit:*
  - *Informatie verzamelen over de ervaringen van het kind met het PAL systeem*
  - *Deze informatie wordt gebruikt om het PAL systeem te veranderen en verbeteren*
  - *Het is geen toets, er zijn geen goede of foute antwoorden en je mag kritisch zijn. Dus als je iets niet leuk vond of als je iets ander wil kan je dat gewoon zeggen.*
- *Vraag voor toestemming om een geluidsopname te maken van het gesprek*
- *Probeer om de vragenlijst in te vullen samen met het kind*
- *Moedig het kind aan om antwoorden uit te leggen en probeer opvolgende vragen te verzinnen. Vooral als het antwoord niet duidelijk is (schrijf de hoofdaspecten van het antwoord op)*

Vragen interactie robot	***Helemaal niet waar***		***Een beetje waar***		***Helemaal waar***
	1	**2**	**3**	**4**	**5**
1. Ik vind het leuk als de robot verschijnt op mijn tablet.					
2. De robot vindt mij heel leuk.					
3. Ik zie de robot als een vriend					
4. De robot en ik brengen al onze vrije tijd samen door.					
5. De robot verzint leuke dingen die wij samen kunnen doen.					
6. Na school en in het weekend spelen en praten de robot en ik graag samen.					
7. Soms doen de robot en ik niets anders dan praten over dingen zoals school, sporten, en wat wij leuk vinden.					
8. Als ik een probleem op school of thuis heb, kan ik hier met de robot over praten.					
9. Als ik ergens last van heb, kan ik het aan de robot vertellen, zelfs als ik hier met andere niet over kan praten.					
10. Als ik de robot binnenkort kwijt ben, ga ik hem missen.					
11. Ik voel me blij als ik tijd met de robot door breng.					

12. Ik denk zelfs aan de robot als ie er niet is.					
13. Als ik succes met iets heb, is de robot blij voor mij.					
14. Soms doet de robot dingen voor me of zorgt ervoor dat ik me bijzonder voel.					

15. Hoe voelde je je tijdens het spelen met de robot thuis?

Kan je uitleggen waarom?

16. Wat vond je het leukst aan de robot op je tablet?

17. Wat vond je het minst leuk aan de robot op je tablet?

18. Kies het antwoord dat een robot het beste beschrijft volgens jou:
Je kan maar één woord kiezen:

- ○ Een machine
- ○ Een vriend
- ○ Een leraar, iemand die iets kan uitleggen
- ○ Een knuffel, iets liefs
- ○ Een technisch speeltje
- ○ Een helper, iemand of iets dat anderen kan helpen

19. Volgens jou kan de robot op de tablet?

Praten of communiceren met iemand	○ JA	○ MISSCHIEN	○ NEE
Bewegen	○ JA	○ MISSCHIEN	○ NEE

- Emoties laten zien ○ JA ○ MISSCHIEN ○ NEE
- Emoties van andere herkennen ○ JA ○ MISSCHIEN ○ NEE
- Herinneren of herkennen van dingen ○ JA ○ MISSCHIEN ○ NEE
- Mij zien ○ JA ○ MISSCHIEN ○ NEE
- Mij begrijpen ○ JA ○ MISSCHIEN ○ NEE
- Anders, namelijk: …

Vragen gebruikers ervaring	***Helemaal niet waar***		***Een beetje waar***		***Helemaal waar***
	1	**2**	**3**	**4**	**5**
20. Ik heb zin om thuis met de robot op mijn tablet te spelen					
21. De echte robot en de robot op mijn tablet zijn hetzelfde					
22. Soms had ik geen zin om met de robot op mijn tablet te praten					
23. Ik vertrouw de robot					

24. Speel je met de robot op je tablet liever O meer / O minder vaak?

G.6 Hangman game

Hangman Dialog

Social Interaction

NAO: Eindelijk iemand die met mij wil spelen!

(NAO stands up)

NAO: Hoi! Ik ben Robin

(NAO handshake: moves arm up and down three times)

NAO: en ik ben een robot, maar dat weet je waarschijnlijk al. Ik woon in het ziekenhuis daar

(NAO points with right arm)

NAO: of misschien is het eerder

(NAO points in opposite direction with left arm)

NAO: daar

(NAO returns to initial standing position.)

NAO: Hmm, ik weet het niet zeker. Robots kunnen ook niet alles weten.

(NAO looks left, then right, then at child again)

NAO: Ik vind jullie woning echt leuk! Veel leuker dan het ziekenhuis.
Kan je je voorstellen in een ziekenhuis te wonen?

(NAO waits for some speech input)

NAO: Ook als het niet zo leuk is zijn er wel veel aardige kinderen die dagelijks langs komen, zoals jij! Ik ben heel blij je nu te ontmoeten! Maar eigenlijk vind ik het niet eerlijk, dat ik hier de enige ben die dingen vertelt! Ik wil ook graag nog meer van jou weten. Laten wij een spelletje spelen waar ik jou een kort verhaaltje vertel en dan ben jij aan de beurt met een verhaal uit jouw leven. Zo leren wij elkaar nog een beetje beter kennen. Ik ga beginnen. Laat me even een verhaaltje bedenken...

(break for two seconds)

Okee, ik weet iets.

(NAO tells story from own life and encourages child to also tell something. NAO listens until it is confident enough that it has heard end-of-speech signal.)

NAO (random choice of):
1. Wow! Dat was echt een spannend verhaaltje!
2. Ik vind het erg leuk jou zo beter te leren kennen.
3. Interessant! Dat wist ik nog niet!

NAO: Nu ben ik weer aan de beurt.

(repeats 3 times)

NAO (after 3rd round): Laatst rondje, okee? Daarna spelen we galgje! Ik begin weer.

(NAO tells story from own life and encourages child to also tell something, then listens until it is confident enough that it has heard end-of-speech signal.)

NAO: Phew! Het is leuk maar ook best wel uitputtend zo veel verhalen te bedenken en te vertellen. Hoe zou je het vinden als wij nu enkele partijtjes galgje gaan spelen? Heb jij daar zin in?

(NAO waits for Ja/Nee speech input)

NAO Ja: Ik ben heel blij dat je met mij wilt spelen! Alleen...
NAO Nee: -

(NAO bows head to look sad)

NAO Ja (continued): ik verlies echt vaak.
NAO Nee (continued): Laten wij het tenminste proberen. Ik hou erg van galgje spelen, en als je het niet leuk vindt kunnen wij er altijd mee stoppen. Ik ben ook geen goede speler, ik verlies echt vaak.

(NAO looks back up)

NAO: Maar eigenlijk geeft het niet of je verliest of wint! Ik vind het zo leuk om met kinderen te spelen. Mensen zijn grappig. Mag ik je een geheim vertellen?

(NAO waits for Ja/Nee speech input)

NAO Ja: Okee, maar je moet een beetje dichter bij komen. (lower volume) Als ik met onderzoekers werk val ik soms express achterover om ze een beetje te laten schrikken... Haha! Je zou hun gezichten eens moeten zien als het gebeurt. Echt hilarisch.
NAO Nee: Okee, dan hou ik het geheim en vertel je in plaats daarvan een mop. Wat staat er op het graf van een robot? Roest in vrede! Haha!

NAO: Oh {name-of-child}, wij zullen veel lol hebben tijdens het spelletje. Ken je galgje al?

(NAO waits for Ja/Nee speech input)

NAO Ja: Fantastisch! Het enig verschil deze keer is dat je alleen letters mag raden en geen hele woorden. Als je een letter wilt zeggen, gebruik dan de woorden op het spiekbriefje. Jouw pogingen en het galgje mannetje zullen op de tablet getoond worden.

NAO Nee: Het is helemaal niet moeilijk. Ik bedenk een woord en dan teken ik een streep voor iedere letter in het woord op dit beeldscherm.

(NAO points to screen)

NAO Nee (continued): Daarna mag jij een letter van het alfabet raden. Als het niet in mijn gekozen woord zit, teken ik een deel van het galgje mannetje aan de rechterkant van het beeldscherm. Als ik alle zeven delen van het mannetje getekend heb en jij nog steeds het woord niet weet, heb jij verloren. Als jouw gekozen letter in het woord zit, zal ik het op iedere stip schrijven waar het voorkomt. Je mag alleen letters raden en niet hele woorden. Als je een letter wilt raden, moet je het alfabet op het spiekbriefje ervoor gebruiken. Heb je alles begrepen?

(NAO waits for Ja/Nee speech input)

NAO Ja: Tof, dan gaan we aan de slag! Ik zal een woord verzinnen en jij mag raden. Als je verliest, krijg ik een punt. Als je een woord helemaal hebt geraden krijg jij een punt. Maar voordat we kunnen beginnen, ga ik nog even zitten. Het kan wel even duren, zo een galgje partijtje.

NAO Nee: Als je nog vragen heeft, stel ze aan {name-experimenter}. Ik neem ondertussen een korte pauze.

(NAO sits down)

NAO: Ben je klaar?

(NAO waits for Ja/Nee speech input)

(if ja: go to game, if nee: experimenter intervenes to help)

Hangman Game

Game Loop

NAO: Okee, laten wij met het galgje spel beginnen! Laat me even een woord bedenken.

(NAO simulates thinking by changing eye colors for a few seconds)

NAO: Okee ik weet een woord.

Round Loop

NAO (if first guess): Maak je eerste keuze en gebruik het spiekbriefje ervoor.

NAO (if not first guess, random choice of):
1. Raad eens een letter, alsteblieft
2. De volgende letter, alsteblieft
3. Raad maar
4. Voor welke letter wil jij nu kiezen?

(NAO waits for speech input)

(if word recognized) NAO (random choice of):
1. Jouw keuze is: + letter ?
2. Jij hebt deze letter geraden: + letter ?
3. Jij hebt voor deze letter gekozen: + letter ?
4. Jouw letter is: + letter ?

(NAO waits for Ja/Nee confirmation)

NAO Ja: break

NAO Nee (random choice of):
1. Sorry dat ik het niet begreep. Herhaal jouw keuze, alsjeblieft?
2. Kun jij de letter herhalen?
3. Het zou fantastisch zijn als je de letter opnieuw zegt!
4. Sorry. Welke letter was het dan?

(go back to top of page until letter is correctly recognized)

(if word not recognized) NAO: Deze letter is niet deel van het alfabet op jouw briefje.

(go back to beginning of round loop)

(if letter in word) NAO (random choice of):
1. Goed gekozen
2. Dit is juist
3. Is goed!

(if letter not in word) NAO (random choice of):
1. Helaas zit deze letter niet in het woord!
2. Dit was geen goede keuze.
3. Helaas fout.
4. Goed geprobeerd maar nee, deze letter zit er niet in.

(if letter has already been guessed before) NAO (random choice of):
1. Je weet dat je deze letter al geraden hebt, toch?

2. Die heb je al geraden!
3. Je dient dezelfde letter niet te herhalen

(update game screen, go back to beginning of round loop)

(if child has won) NAO (random choice of):

1. Woehoe, jij hebt gewonnen! En ik ben de verliezer.
2. Jij bent de winnaar! En ik heb dit spel verloren.
3. Gefeliciteerd! Jij hebt het spel gewonnen! Dat betekent dat ik de verliezer ben.
4. Jij bent een professionele galgje speler, toch? Jij hebt gewonnen! Ik helaas niet.

(if NAO has won) NAO (random choice of):

1. Whoehoe! Ik heb gewonnen!
2. Oh nee, jij hebt verloren. Dat betekent dat ik de winnaar ben!
3. Helaas moet ik je vertellen dat je verloren hebt. Dat betekent dat ik gewonnen heb!
4. Jij hebt verloren! En ik ben de winnaar!

NAO: Hmm, het woord was {word}. Nu schiet me nog een verhaaltje te binnen!

(NAO tells another story and encourages child to do the same, then listens for end-of-speech signal)

End of round loop

NAO: Wil jij nog een partijtje spelen?

NAO Ja: Tof! (go back to beginning of game loop)

NAO Nee: Jammer, maar ok, dan gaan we iets anders doen!

End of game loop

NAO: Ik vond het ontzettend leuk met je te spelen! Dat moeten we echt eens herhalen!

(NAO waves for goodbye)

G.7 Intimacy rating instructions

Intimacy Rating Instructions

You are asked to rate a number of English statements on how intimate you think they are. Statements were gathered in a long-term interaction study with children and a virtual and physical agent. Statements are divided into two categories: statements coming from the robot and statements coming from the children. All statements are statements about the self. Such statements are called self-disclosures. The one who self-discloses is the *discloser*, the one who listens is the *receiver*. In the case of child-disclosures, the robot is the receiver and in the case of robot disclosures, the child is the receiver. Self-disclosures can be more or less intimate. Intimacy here should be understood as ***the degree to which the statement reflects information about the self that is sensitive***. This is also reflected in who we are willing to share information with. For example, an information about yourself that you would readily share with everyone would be very low in intimacy, while something that you would only or not even tell your very best friend or partner is very high in intimacy. We have developed a model for intimacy that should allow rating statements for how intimate they are. The model is represented by the following equation:

Intimacy(self-disclosure) = Risk(social rejection) + Risk(betrayal)

Risk can be formalized as the product of probability (P) and impact (I). If we further assume that social rejection does not occur at random but only follows if the disclosure is negatively appraised, we can approximate the risk of social rejection through the risk of negative appraisal:

Intimacy(self-disclosure) = P(negative appraisal) * I(negative appraisal) + P(betrayal) * I(betrayal)

These considerations have led us to the following four levels of intimacy with NA = negative appraisal and B = betrayal:

Level	*Description*	*Example Statement*
low	P(NA), I(NA), and I(B) are low or zero: the discloser cannot be evaluated on the basis of the statement or the statement is very common-place.	“I have a lot of brothers and sisters."
Moderate	P(NA) is moderate, because statements are more opinionated, but I(NA) and I(B) are low. Negative appraisal can at best take the form of disagreement. The information cannot really be exploited, so that in the case of betrayal, no loss is to be expected. Includes preferences and opinions on activities and objects.	“I like online games in which you have to team up with other players."
High	Either P(NA) is high and I(NA) is low (the content conflicts with the norms of the recipient but does not reflect on the character	“I'm really disappointed that my sister will not try yoga with me. She

	of the discloser), or the content is of great significance to the discloser, in which case I(NA) and I(B) are high. Disclosures are emotional and may include evaluations of other people.	already promised it twice but never followed through."
Very high	P(NA), I(NA), and I(B) are high, because the disclosure is at the core of the discloser's self-concept and could easily conflict with the norms of the recipient. In the case of betrayal, great emotional, physical, or material damage may ensue. Social stigmas, self-doubt, deep personal fears, and secrets are accumulated on this level.	"Whenever I work really hard or I'm nervous, I start sweating like crazy. I can't get close to people then, because I'm really conscious of how I smell."

Your task is to judge the intimacy of each statement on the above four-point scale. This means that to each statement you should assign a value from 0-3 depending on how intimate you think it is with 0 being low, 1 being moderate, 2 being high, and 3 being very high. Make sure that you have understood each level description before starting. If you have any questions concerning the scaling, please ask. If you are very uncertain for a certain statement, choose the intimacy level that fits best according to your opinion, but mark the statement in some way. Keep in mind that statements were written for/by children between the ages of 8-12.

H MyPal Application

To obtain an impression of the user experience of the application and more specifically of the disclosure loop, some screenshots are provided below.

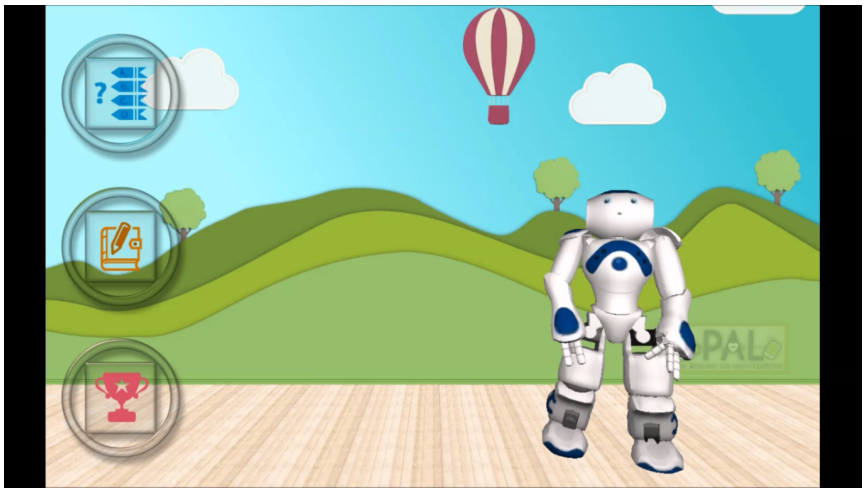


Figure 14: When children open the application, this is presented to them. They can choose on the left between the quiz (top icon), the diary (middle icon), and viewing their objective (bottom icon, not used in June evaluation).

Figure 15: The child has selected the diary. The avatar makes a disclosure.

Figure 16: The avatar prompts the child to disclose.

Figure 17: The child is given the choice whether to respond or not.

Figure 18: Child has chosen yes. This opens a text input field.

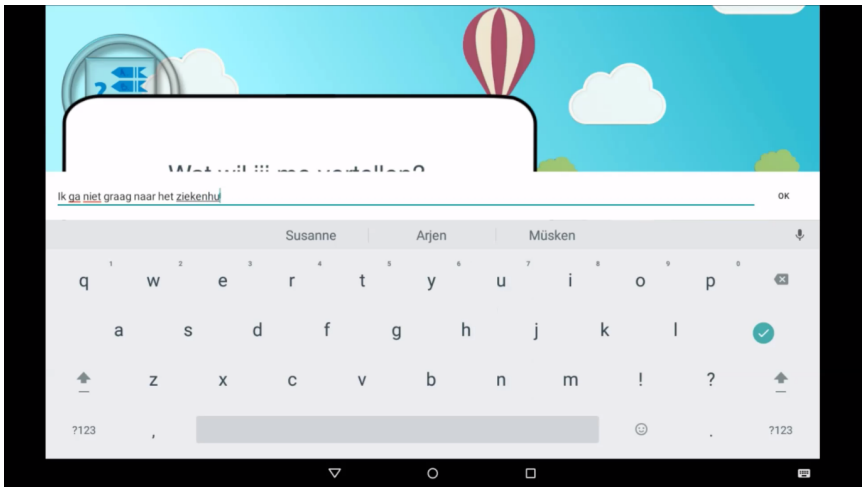


Figure 19: Child types some text and presses return.

Figure 20: The avatar thanks the child for sharing.

Figure 21: The avatar says that they should now return to the diary, finally ending the dialog.

Figure 22: The diary opens.

Declaration of Authorship

I hereby declare that the content of this thesis is entirely my own work. Whenever the work from published or unpublished sources was employed, the authorship has been acknowledged in the text and can be found back in the reference list of the thesis or respective appendix. Furthermore, I assert that this work has not been used to obtain any other degree or diploma.

Franziska Burger