# How close do you feel to your devices?

## Visual assessment of emotional relationships with digital devices

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## ABSTRACT

With modern digital devices becoming more adaptive and more personalized, usage behavior has changed dramatically. Devices are no longer mere technological equipment but are discussed to be "social companions" [1]. However, measures, scales and instruments barely keep in step with both the new ways of usage and the resulting new perspective on the devices [2]. Thus, measurements focusing on social and relational aspects of modern media use are rare. This paper addresses the need to develop new methodological approaches. Further, as online assessment tools are increasingly popular but face design-related disadvantages (e.g., termination, uncertain quality of data) it argues for a high quality design process. Consequently, this paper focuses on a new online instrument (labeled POD 1.0: Positioning Others and Devices) which has been developed to assess the relationship between users and their devices [1]. However, the first version of this tool raised problems (e.g., user errors, dropout rate). By attributing these shortcomings to design and layout [6, 11], a heuristic expert analysis of problems was conducted following a user-centered-design process (UCD). Three low fidelity prototypes resulted and were evaluated with evaluations leading on to the final prototype: POD 2.0. Further, this POD 2.0 was evaluated. 44 participants engaged in a long-term user study. Compared to the original tool, results revealed an improvement of both effectivity and satisfaction of the instrument.

In sum, the present study brings instruments to focus which assess social and relational characteristics of a long-term user-device interaction. Further, user-centered-design processes are adopted to modify and refine the POD 1.0 indicating a promising way to improve the goodness of online assessment tools.


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## CCS CONCEPTS

• Human-centered computing → Human computer interaction (HCI) → HCI design and evaluation methods: *Heuristic evaluations; User studies; Field studies* • Human-centered computing → Interaction design • Human-centered computing → Human computer interaction (HCI) → Interactive systems and tools → User interface programming

## KEYWORDS

POD, UCD, long-term user-device interaction, human-device relationship, digital companionship

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## 1 Introduction

In contrast to media use a few years ago, media devices have become more personalized and adaptive resulting: nowadays, devices offer a variety of features and accompany their owners throughout the day. Referring to core characteristics of human-human relationship Carolus, Binder, Muench, Schmidt, Schneider and Buglass (2019) introduced the concept of a 'digital companionship' between smartphone users and their devices [1]. Both constituting and outcome characteristics of social relationships were transferred to a model of human-smartphone relationship which was tested empirically. As a result, the idea of a 'companionship' was considered as a fruitful approach to further analyze the use of digital devices as well as its effects.

Following these conceptual thoughts, Wienrich, Döllinger, Kock, Schindler, and Traupe emphasized that measuring social or relational aspects of a human-computer interaction becomes more important resulting in methodological considerations of new possibilities to assess the experiences [2, 3]. Contrasting common aspects of user experience, 'companionships' or social relationships develop over time and require repeated interactions. To meet these requirements methodologically two ways are to be

considered: (1) repeated time points of measurement to trace processual aspects of the relationship or (2) a one-time measurement which is considered as the outcome of preceding repeated interactions. In addition, as social relationships usually develop in natural interaction contexts (e.g., at home or at work) a laboratory setting might be counterproductive and might reduce the external validity. Carolus et al. (2019) introduced a first attempt to meet these requirements. Their 'POD: Positioning Others and Devices' (POD 1.0) constitutes a first version of an online instrument which focused on the outcome of an ongoing relationship between smartphone users and their smartphones (details see below) [1].

However, technical and design-related limitations restrained the operational capability of the instrument. The present study argues that online tools need to be developed and evaluated more carefully, following a user-centered-design process (UCD), for example. Thus, the present study aimed for a detailed analysis of the POD 1.0 to identify developmental potential and to improve its goodness. As a result, potential of improvement was derived and translated into newly constructed prototypes. Subsequently, a multi-step evaluation resulted in a revised version (POD 2.0) which was also evaluated. In a long-term field study, usability was tested. Moreover, associations between the POD 2.0 scores and further measures of the social relationship between the user and the device were analyzed offering first steps of criterion validation of the POD 2.0.

## 2 Background and Related Work

### 2.1 User-Centered-Design

Norman and Draper (1986) [16] introduced the user-centered-design process which condensed different approaches and methods known in the field of human-computer interaction. Overall, the basic steps consist of an analysis identifying relevant problems occurring when using a system. Integrating different perspectives, the approach of contextual design [9] involves users detecting problems (e.g., contextual inquiry; focus groups) and the approach of usability engineering [14] involves experts who also detect problems and find solutions (e.g., heuristics, cognitive walkthrough) [15, 20, 21]. Wireframes and low fidelity prototypes are developed offering first solutions of the problems identified (design). They provide the main functions while being adaptable with low expenditure. Evaluation is essential since users and experts iteratively evaluate the wireframes and prototypes. Finally, when no more problems are identified the main prototype will be implemented and the potential target group evaluates it. Figure 2 demonstrates the common steps of the UCD process and how they are intertwined. Usually, early steps incorporate a formative evaluation while later steps incorporate summative evaluations.

### 2.2 User-Centered-Design for Assessing Tools

A variety of use cases are based on the UCD process. For example, Garrett (2002) [7] described UCD for web applications including prototypically web sites. In a scientific context, web sites presenting questionnaires or tools collecting participants' data were analyzed. While online assessments on the one hand offer various advantages (e.g., reaching many participants simultaneously, absence of examiner) there are also disadvantages to consider. On average, 15% of the participants terminate online assessments [12]. The lengths of the assessment, the complexity of the questions as well as both design and layout of online tools are major reasons for termination [6]. In sum, adapting UCD to the designing of online assessments tools is regarded as another important factor complementing well-established goodness of fit parameters (i.e., objectively, reliability, and validity) to ensure the quality of data assessment.

### 2.3 Positioning Others and Devices: The POD

As briefly introduced above, Carolus et al. (2019) developed an online tool to visualize participant's closeness to both media devices and other persons. They focused on smartphones which were conceptualized to be 'digital companions' referring to owners who are emotionally attached to their phone and who feel emotionally close to them. To assess this closeness to the phone they developed their online instrument POD 1.0 which built on a technique known from systemic family therapy. The authors adopted the basic idea of the 'Familiensystem-Test' (family system test) which psychotherapists use to visualize cohesion and hierarchy within the families [8] by positioning pieces representing different family members on some kind of chessboard. Basically, users of the POD 1.0 were instructed to indicate the importance of both (1) a range of relevant others (e.g., family members, friends, colleagues) and (2) media devices they use (e.g., phone, computer, radio) by positioning pieces representing them on a board. At the beginning of the procedure, a collection of 15 pretested significant others was presented and participants were instructed to 'provide the name of one specific person of your social environment' for every category (quote: original text of the tool). When no person was accessible cognitively, the category was left blank and diminished, later. Second, a list of ten media devices was presented and participants were instructed to 'select all media devices you have yourself or that you use regularly' (again: original text). Third, an icon representing 'me' was presented next to a 9 x 9 grid. Participants were instructed to position 'the piece representing yourself [...] on the chess board'. Then, icons representing the people and devices they had selected before were presented. Participants were instructed to also position them on the board to indicate 'how important these people and devices are' with 'the more distance there is between your own piece and that of another person the less importance this person/device carries'. The instructions used the term 'importance' rather than 'closeness' because closeness could be interpreted in two ways: (a) 'distance' – which is probably more obvious when positioning devices and (b)

'emotional relevance' - when placing human beings. Figure 1 illustrates the basic idea of the POD.

To analyze participant's final boards, the distances between the pieces were calculated. On a 9x9 board, Euclidean distances ranged from 1 (neighboring space) to 11.31 (two pieces occupying the endpoints of one of the diagonals).[1] Carolus et al. (2019) then introduced a set of indices to assess the participant's closeness relative to the closeness to significant others as well as other devices.

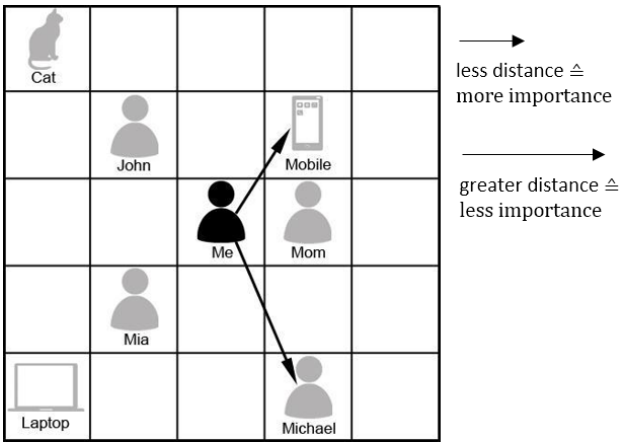


**Figure 1: Sketch of the basic idea to position significant persons and media devices in relation to myself** [1].

In a huge cross-national study (n = 1156) plausibility of the POD was confirmed with results revealing partners and family members to be the closest to participants' 'me' piece. On average, media devices are less close than humans with the smartphone being the closes device, followed by laptop and computer. In sum they concluded, the POD to work well as a new methodological approach to contribute to offer a promising approach to assess human-computer relationships.

However, a follow-up analysis of their data revealed an increased dropout rate for the POD. Experts interviewed detected technical and design-related problems resulting in limited operational capability of the instrument and limited usability as well as user experience, therefore. To close the gap, the present paper aims for a more in-depth analysis of these problems. Following a user-centered-design process (UCD), this study modified the POD 1.0 and presented a revised version (POD 2.0). In a long-term field study, the new POD 2.0 was evaluated regarding aspects of both usability and user experience.

## 3 UCD in the Present Study

To improve the POD 1.0, we selected a mix of UCD methods consisting of two steps: a formative and a summative phase (Figure 2). The formative phase (see part 4) started with an expert analysis of the POD 1.0. To detect usability problems, experts were asked to examine the interface and judge its compliance with well-established usability principles introduced by Nielsen (1994) [14]. Subsequently, first solution approaches were derived and transferred into a wireframe (low fidelity prototype) which was evaluated twice. Afterwards, the summative phase followed (see part 5). In a long-term field test both effectivity and satisfaction with the POD 2.0 were assessed. While the original study focused on smartphones, our study focused on smart speakers. Thus, participants received either an Amazon Echo or a Google Home Mini which they took home for six days. During this time, participants interacted with the device and had to answer questionnaires evaluating these interactions. The newly modified POD 2.0 was answered three times – prior to the interaction, after the second, and after the fifth day of interaction. Briefly summarized, POD measures were analyzed regarding associations with standard questionnaire items also aiming for an assessment of the relationship between user and devices.

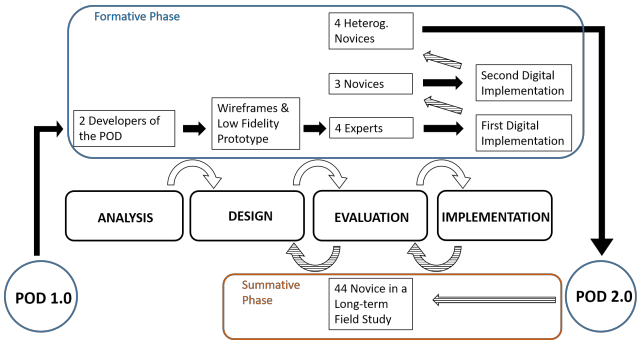


**Figure 2: A process model to develop a new version of the POD following user-centered-design process**

## 4 The Formative Phase

### 4.1 Identifying Problems

Five usability experts analyzed the POD 1.0 following Nielsen's heuristics. The conflicting aspects were rated regarding severity. Table 1 gives an overview of these heuristics, the problems which POD 1.0 raised and the improvements POD 2.0 implemented.

[1] Distance between each piece: $d(x, y) = 2(y1-x1)^2+(y2-x2)^2$

**Table 1: Nielsen's heuristics adapted to the POD 1.0**

| Heuristic | POD 1.0: Problem | POD 2.0: Improvement |
|---|---|---|
| Visibility of system status | No system status visible. | Progress bar in the right top corner. |
| Match: system and real world | | Easy switch between languages. |
| User control and freedom | Use of navigation buttons of the web browser results in termination and data loss. | To prevent data loss, input was also saved via session storage of the web browser. If user closes browser tab, a warning message will pop up asking if the user really wants to end the session (yes/no). |
| Consistency and standards | Elements of similar functions rather randomly positioned. | Similar elements grouped (e.g., sidebar, next button). |
| Error prevention | Referred to by the other heuristics. | |
| Recognition rather than recall | Instructions and important information were only given once, at the beginning of the test procedure. | New sidebar keeps instructions/information available at any time during test procedure. Videos were integrated for each step of the procedure explaining the upcoming task. |
| Flexibility and efficiency of use | Programming limits usage to desktop browsers. | Responsive design, *CSS Flexible Box Layout* (i.e., *Flexbox*) allows to perform the POD 2.0 on various devices. |
| Aesthetic and minimalist design | Dialogues contained superfluous information distracting from relevant information. Icons/graphics were ambiguous. | Dialogues were condensed and rephrased. Graphics were stripped-down with icons following state-of-the-art design guidelines. |
| Help users recognize, diagnose, and recover from errors | Error messages were ambiguous or missing (e.g. browser buttons terminating POD). | New error messages precisely indicated the problem and suggest a solution. Further, to avoid mistakes, error-prone conditions were eliminated. |
| Help and documentation | Referred to by the other heuristics. | |

## 4.2 Wireframe and Low Fidelity Prototype

To develop the wireframes, the user experience design software application Adobe XD published by Adobe Systems was used. Hence, wireframes addressed the problems of the POD 1.0 (Table 1, column 2) and offered first solutions (column 3). To give an example, Figure 3 shows a screenshot of both the original as well as the modified POD version. (1) A progress bar visualized six steps representing the six main steps of the POD 2.0. The bar was visible in the top right corner throughout the procedure. (2) Data was stored until the tab of the browser was finally closed. A warning message popped out asking if the user really wants to end the session. Thus, using browser buttons to navigate did not risk data loss. (3) Elements were relocated to group similar functions: next button in the bottom right corner, sidebar at the right side, and pieces which participants had to position could be found on the left side. (4) For every step of the POD 2.0, the user could find the current instructions in the sidebar which allowed the user to retrieve instructions and important information at any time during the test procedure. Furthermore, videos were integrated. For each step a short video (recording of a screen showing the POD) visualized and explained the upcoming task in detail. To carry out the first user study, the final wireframes were printed serving as low fidelity prototype.

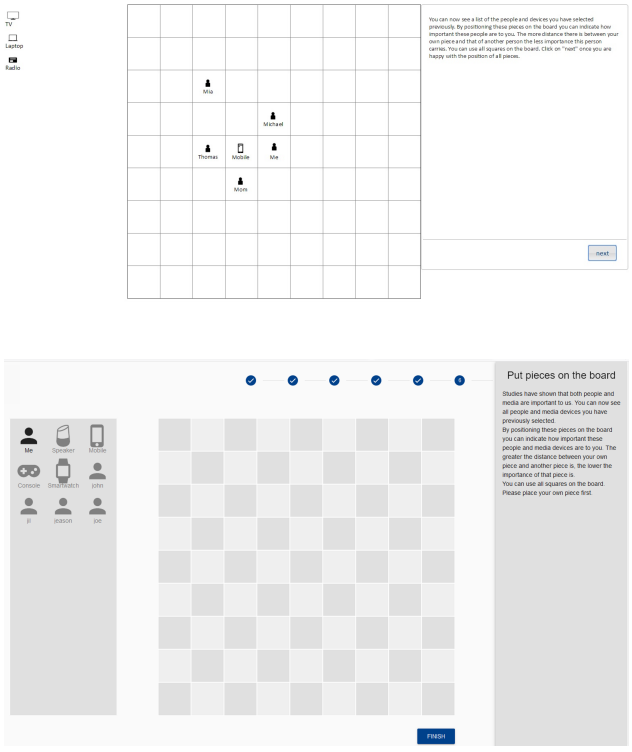


**Figure 3: Screenshots of POD 1.0 (top) and POD 2.0 (bottom).**

### 4.3 Low Fidelity Prototype: User Test

Four students (two females, two males) who had completed the POD 1.0 before, evaluated the low fidelity prototype. An examiner moderated the interaction, a second examiner recorded the participants' comments who had been encouraged to think aloud during the procedure.

Following the procedure of POD 2.0, the participants were presented a list of categories of persons (e.g., partner, friends, siblings, father, mother). For each category they could note down a certain person. However, they were not forced to. If they could not think of a relevant example of the category, it could be left blank. Next, a list of devices was presented. Participants were instructed to select the devices they used on a regular basis. Afterwards, they were presented the grid and were instructed to position a 'me piece' representing themselves on it, first. Then, the selections of significant other persons and of devices they used were presented. To indicate their importance, participants had to position these pieces on the grid. The instruction said: 'By positioning these pieces on the board you can indicate how important these people and devices are to you. You can use all squares on the board. The more distance there is between your own piece and that of another person or media device the less importance this person or devices carries.'

In general, the improvements of the POD 2.0 were positively appraised (e.g., consistent interface, progress bar). However, participants identified three problems. (1) It remained unclear, if icons that had been placed once, could be relocated afterwards. (2) Participants asked if vertical and horizontal fields are as far apart from each other as diagonal fields (see Figure 3). (3) Participants were unsure if they had to place the icons in a given order (e.g., persons first, devices afterwards) or if they are free to choose.

### 4.4 First Digital Prototype: User Test

The first digital prototype found solutions of the three problems the low fidelity prototype testing revealed. (1) Icons which were positioned could be relocated as long as users push the finish button. Accordingly, the instruction was rephrased with a hint always visible in the sidebar box. (2) When all pieces were positioned, a dialog window pops up reminding the user of fields bordering vertically/horizontally to not have the same distance as fields bordering diagonally. Users were allowed to relocate their icons, again. (3) During positioning phase all selected icons were visible and could be placed simultaneously.

The browser-based frontend was implemented by using Vue.js as a framework. Its component system allowed the modularity of programed components, a single-page-web application as well as a state management resulting in a performant application, less error-prone, and easy to administrate. The interface design followed the *Material Design System* [13] published by *Vuetify.js* [22]. Hence, current design guidelines were followed enabling responsive design and allowing the use of different devices, therefore (*CSS Flexible Box Layout*; i.e., *Flexbox*). To implement a German and an English version, the i18next (https://www.i18next.com/) of JavaScript was used. Thus, the user could choose the languages at the start. The data of the frontend were written in a MySQL database (backend). When the users began to position pieces on the grid, two *Ajax-Requests* would be triggered (coordinates of the icons; Euclidean distances between the me icon and the other icons). Further, an administration area was implemented with databases allowing to organize and export data (.csv files).

The first digital prototype was tested by three students (two females, one male) instructed by two examiners. Basically, the procedure followed the first test. However, participants had not used a POD instrument before, this time.

The three problems of the first test did not occur again. Thus, the improvements solved the problems satisfactorily. However, two major problems were reported by all participants forcing us to cancel the test. (1) The sidebar was foldable and needed to be folded out whenever the participants wanted to read them. Although this was explained in the introduction video the participants had problems to handle the sidebar. (2) Due to design restrictions the names that needed to be written down for each category were limited to ten characters only. The test revealed that participants struggled with shortening names and tended to choose a different person with a shorter name.

### 4.5 Second Digital Prototype: User Test

Improvements resulted in a second digital prototype. (1) The sidebar was fixed at the left side to avoid users missing important information. (2) The video explicitly instructed participants to use abbreviations of names exceeding ten characters. Four participants (two females, two males) with two students and two older employed persons represented a more heterogeneous sample. Again, they had not used any POD instrument before. Instructions followed the study before. All participants reported the POD 2.0 to be an instrument easy to use. Further both the video and the sidebar instructions were evaluated positively. No further problems were detected. Thus, the second digital prototype was ready-to-use in a long-term field study.

## 5 The Summative Phase: A long-term field study

Finally, a field study was conducted to test POD 2.0 regarding its usability and its association with further measures of the user-device relationships to allow firsts steps of criterion validation of the POD 2.0.

### 5.1 Methods

*5.1.1 Participants.* 44 students (35 females, 9 males, age: $M$ = 20,64, $SD$ = 2,23, range from 18 to 30) participated in the long-term field user test of the POD 2.0. Participants were rather technique affine ($M$ = 3.97, $SD$ = 0.85, scale ranged from 1 to 6) and had high innovation skills ($M$ = 4.09, $SD$ = 0.66, scale ranged from 1 to 5). Further, regarding psychological aspects, they reported an average trustworthiness ($M$ = 3.25, $SD$ = 1.10, scale ranged from 1 to 5) and an average fear of missing out [18] score ($M$ = 2.93, $SD$ = 0.75, scale ranged from 1 to 5). Less than five percent of them reported experiences with smart speakers.

*5.1.2 Material and Procedure.* The long-term study was divided into three sections.

(1) In the **pre-test section** at the laboratory, participants answered a screening questionnaire assessing demographical data and the POD 2.0. Afterwards, they received either an Amazon Echo Dot (third generation) or a Google Home Mini which they took home.

(2) During **interaction section**, participants used Echo/Google Home for six days (Tuesday until Monday). Each evening at six o'clock, they had to answer a questionnaire. At the second and at the fifth day the **POD 2.0** was included. Moreover, the Inclusion of Others in the Self Scale (IOS) [4] was answered. IOS Scale is a pictorial measure of **closeness** (single-item) which refers to closeness to other human beings, originally. Following Carolus et al. (2019) the item asked for the closeness to the 'smart speaker'. Further, **social presence** was assessed [17] by using a module of the Game Experiences Questionnaire (sGEQ) consisting of three subscales: *empathy, behavioral involvement, and negative feelings* [11]. Since the items of the subscale *negative feeling* did not fit into our use case, only **empathy** and **behavioral involvement** were used. Again, 'other' was replaced by 'smart speaker'. These additional scales were assessed at the second and fifth day of interaction. Items were answered on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

In sum, the measures presented aimed for the assessment of relational or social aspects of the user's interaction with a smart speaker. To gain first insights into this interaction and to further evaluate the POD 2.0, associations between POD scores and the other indices were correlated (Pearson procedure).

(3) In the **post-test section**, two examiners conducted a structured interview to evaluate participants' use of POD. They assessed both effectivity and satisfaction with the different steps of the procedure (question 1: 'Did you recognize problems during selecting procedure?'; question 2: 'Did you recognize problems during placing procedure?'; question 3: 'Did you have to terminate? Why?'; question 4: 'How did you like the idea of the tool to assess the relationships between both humans and humans as well as devices?'). Finally, **QUESI** questionnaire [10] was applied asking for the dimensions *perceived mental workload*, *perceived achievement of goals*, *perceived effort of learning*, *familiarity*, and *perceived error rate*. Questionnaire items were answered on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Additionally, correctness and completeness of data stored in the database were checked as a further indicator of the effectivity of POD 2.0 (following the ISO 9241-11, 2018).

## 5.2 Results

Analysis of the database revealed the data to be complete. For all three measurement time points no missing values were recorded. Further, no server problems were reported. Thus, the usage of the POD 2.0 is evaluated to be effective.

Table 3 gives an overview of correlations between the POD 2.0 and the other measures. On day two, POD 2.0 and IOS correlated significantly, empathy (sGEQ subscale) reaches significance level by trend. At day five, all correlations increased. Since correlations depend on the variation of data, an increase over time seems reasonable. Again, POD 2.0 and IOS correlated significantly. Furthermore, the correlation between POD 2.0 and empathy reached significance level. To understand correlational values correctly, POD 2.0 scores need to be considered: lower values indicate greater closeness on the board. Thus, negative correlations were expected.

**Table 3: Correlations between POD 2.0 and IOS, sGEQ and CCPIG**

| **Subscales on the second day** | **r** | **p** |
|---|---|---|
| IOS | -0.31 | 0.05* |
| Empathy of sGEQ | -0.30 | 0.06 |
| Behavioral Involvement of sGEQ | -0.01 | 0.98 |
| **Subscales on the fifth day** | **r** | **p** |
| IOS | -0.38 | 0.01* |
| Empathy of sGEQ | -0.33 | 0.03* |
| Behavioral Involvement of sGEQ | -0.15 | 0.35 |

Notes. *: $p < .05$

On a Likert scale ranging from 1 to 5, all QUESI subdimensions scored above average (see Table 2). In combination with benchmarks Hurtienne and Naumann (2010) [10] offer, the POD 2.0 is evaluated to be both easy and satisfying to use.

**Table 2: Evaluation of POD 2.0 – QUESI results**

| **Subscale** | **M** | **SD** |
|---|---|---|
| perceived mental workload | 4.14 | 0.89 |
| perceived achievement of goals | 3.97 | 0.97 |
| perceived effort of learning | 4.33 | 0.73 |
| familiarity | 4.02 | 0.88 |
| perceived error rate | 4.28 | 0.98 |
| Over all | 4.15 | 0.16 |

Notes. *Values ranging from 1 to 5.

The results of the interviews support these results. Most participants were satisfied with the tool and did not report any problems when using POD 2.0. Especially the chessboard interface was evaluated positively. However, some participants criticized the chessboard to be too small, one participant suggested a cycle-like interface enabling a more continuous positioning of the pieces. Further, two insecurities occurred. One participant selected a certain person category but did not name it resulting in a blank piece to position. Another participant was not sure, if he/she could navigate via the browser buttons.

# 6 Discussion

Online assessments and online measures are increasingly popular. However, besides many benefits (e.g., addressing many participants simultaneously, absence of examiner, more natural context than laboratory studies), online assessments face disadvantages (e.g., termination, uncertain quality of data). Consequently, the present study argues that online tools need to be developed and evaluated carefully – with design and layout of the tool to be especially relevant. Although the UCD process has been shown to be a fruitful approach the scientific development

of online assessment tools rather neglects this concept. The present study applied the UCD process to check and improve the goodness of an online tool (POD) which assesses social and relational aspects of a user-device interaction. While the original study of the POD 1.0 focused on smartphones, the present study focused on smart speakers. After a heuristic expert analysis of potential problems, three low fidelity prototypes were derived and evaluated by users. As a result, a final digital prototype was developed – labeled POD 2.0. This new version was evaluated by 44 participants who took part in a long-term user study. Analysis of quantitative as well as qualitative data indicated that both the effectivity of the tool as well as the user satisfaction have increased. Furthermore, POD 2.0 scores were shown to significantly correlate with the IOS scale which refers to the closeness to the smart speaker. Additionally, POD 2.0 scores significantly correlated with the empathy scale of sGEQ referring to the user's capacity to feel or understand what the smart speaker 'is experiencing'. QUESI revealed the POD 2.0 to be both easy and satisfactory to use. In sum, these results constitute first steps of an analysis of criterion-related validity of the POD 2.0 as it can be shown that instruments assessing similar constructs correlate substantially.

### 6.1 Limitations and future Improvements

Participants of the long-term study reported some insecurities which did not result in severe problems. However, future modifications need to further improve instructions to (1) remind the user to name every icon representing a person or a device and to (2) explicitly instruct browser navigation. Although responsive design results in the POD 2.0 to be compatible with different devices, a screen of at least nine inches is recommended. Consequently, POD 2.0 is not recommended for smartphone use which limits the field of application. Future improvements should focus on a smartphone version, therefore. Further, a rather continuous approach (circle grid) could be discussed. Future studies could test different approaches, different designs and concepts to assess social and relational aspects of a user-device interaction to aim for the most valid version. In addition, the administration area offers limited features. Advanced data handling and data preparation (e.g., graphical output) would contribute to a more detailed data analysis. As the administration was not evaluated, future research needs to continue the UCD process, here. POD scores were interpreted as indicators of closeness to the smart speaker. However, the instructions simply ask for 'the importance' of the devices/humans, but not for, e.g., the emotional closeness. In future studies we will vary the latent variable and the wording, therefore. For example, participants will be instructed to indicate the 'valence of the relationships', the 'emotional closeness' or the 'functionality' and 'dysfunctionality'. While the present study offered first insights regarding criterion validation, these efforts need to be stepped up by implementing further constructs and measures.

## 7 Conclusions

The present study addresses the need to develop new methodological approaches to account for the user behavior of modern digital devices. The idea of a user being in an emotionally relevant relationship with his/her device ('digital companionship') provides a heuristically fruitful approach widening the perspective of human-computer interaction. To assess dimensions of this relationships, new instruments need to be developed exceeding standard questionnaires. Furthermore, these instruments needs to be evaluated and improved systematically. UCD processes were shown to offer valuable insights complementing well-established goodness of fit parameters (i.e., objectively, reliability, and validity) to ensure the quality of data assessment.

In sum, this study illustrates the iterative design and improvement process of an existing online assessment tool resulting in a new version called POD 2.0. Evaluations studies confirm the goodness of the new tool. Further, results confirm and reinforce the idea of digital devices to be emotionally relevant for their users. Conceptualizing a 'digital companionship' and describing constituting characteristics offer starting points for future research analyzing this relationship thereby referring to potentially (psychological) benefits of the use of media devices.

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