# Smartphones as digital companions:

## Characterizing the relationship between users and their phones

Astrid Carolus[1], Jens F. Binder[2], Ricardo Muench[1], Florian Schneider[1], Catharina Schmidt[1], and Sarah L. Buglass[2]

[1]Julius-Maximilians-University Wuerzburg, Germany

[2]Nottingham Trent University, UK

MANUSCRIPT ACCEPTED IN NEW MEDIA & SOCIETY. PRE-PUBLICATION VERSION; DO NOT CITE.

**Corresponding Author:** Astrid Carolus, Media Psychology, Institute for Human-Computer-Media, Julius-Maximilians-University, Oswald-Kuelpe-Weg 82, 97074 Wuerzburg, Germany. Email: astrid.carolus@uni-wuerzburg.de

## Abstract:

Based on the idea of computers constituting social agents and referring to core characteristics of human-human relationships, this study introduces the concept of a digital companionship between smartphone users and their devices. Constituting characteristics (closeness, trust, preoccupation) and outcomes (stress, coping with stress) of social relationships were adapted to yield a model of human-smartphone relationships for empirical testing. A cross-national sample of participants (n = 1156) completed an online study which included self-report measures as well as a newly developed instrument (Positioning Others and Devices; POD) assessing the closeness to technical devices and social actors. Results showed the smartphone to be the closest device. Further, structural equation modelling lent support for the theoretical model indicating that trust and preoccupation mediate the relationship between closeness to the smartphone and stress and coping. Findings support the concept of companionship as a fruitful approach to explain smartphone-related behaviors.



## Keywords:

Smartphone, relationship, human-smartphone relationship, mobile devices

# 1. Being with your phone 24/7: Smartphones as digital companions

For how long had you been awake this morning until you reached for your smartphone for the first time? Whether it is texting, email, music, browsing or navigation, smartphones are technological devices offering a wealth of functions supporting their users in everyday lives. Smartphones are among the most popular devices worldwide. Globally, nearly 1.5 billion units were sold in 2016 (Van der Meulen & Pettey, 2017). About 70% of the population in Western Europe and in the United States use a smartphone in 2018 (Newzoo International B.V., 2018) with 65% of British owners under 35 years looking at their phones within five minutes of waking up. In 2017, they spent nearly 169 minutes per day using their mobile, with users aged between 15 and 24 spending more than four hours (Office of Communications, 2018).

Smartphones are still a comparatively new phenomenon, having gained rapid and worldwide popularity since the launch of Apple's first iPhone in 2007. In contrast to mobile phones used until then, the iPhone and all subsequent smartphones launched by competitors (Samsung is currently listed as the global market leader; Van der Meulen & Pettey, 2017) fundamentally changed the way mobile phones were used. By incorporating a variety of features which previously had been distributed over a range of devices, smartphone distribution as well as usage have increased sharply over the course of one decade. Up to the ages of 35 to 40 nearly everybody in the Western world uses a smartphone, with the gaps to older strata of the population shrinking (Olmstead, 2017). The commonplace observation of people being permanently in touch with their phones has been approached from different perspectives by researchers (Vorderer, Hefner, Reinecke, & Klimmt, 2018).

A technical or pragmatic approach argues that a smartphone integrates functionalities previously spread over several devices (such as telephone, camera, navigation system, music player). According to Displacement Theory, the smartphone outperforms the older, less efficient devices and replaces their functionalities resulting in an increasing time of usage (e.g., Okazaki, Li, & Hirose, 2009). Thus, intensive usage seems to be rather a consequence of displacement than a proof of addiction, at first. However, current research tends to stress problematic and addictive phone use (Kuss & Lopez-Fernandez, 2016; Young, 2015) just as it has been done with regard to the internet in general or specific online services (particularly Facebook; e.g., Ryan, Reece, & Xenos, 2014). In contrast, the present study does not follow the perspective on the smartphone to constitute an addictive substance, but focuses on smartphones to be portable and to accompany their users throughout the day, ever-ready to fulfil tasks (e.g., communication with friends and family). We consider these functions to be linked to underlying fundamental psychological needs (e.g., need to belong; Baumeister & Leary, 1995) resulting in our basic postulate of the smartphone to be to its owner not mere technical equipment but rather a 'digital companion'. Conceptualizing a digital relationship between the user and the phone changes the research perspective on smartphone usage radically. Both theoretical concepts and methodological approaches established for

human-human relationship can be analyzed and tested in respect to their transferability to human-smartphone relationships.

As an explanation for the popularity of smartphones, both the outlined usability and functionality cannot sufficiently account for behavioral patterns which have led academic and popular science to generate labels such as addiction (Samaha & Nawi, 2016; Davies, 2017), phantom vibration (Tanis, Beukeboom, Hartmann, & Vermeulen, 2015; Knapton, 2016), phubbing (neologism: 'phone' and 'snubbing'; Roberts & David, 2016), or smombies ('smartphone' and 'zombie'; Hookham, Togoh, & Yeates, 2016). Psychological research so far has focused on the use of services or applications (e.g., social media in general: Blackwell, Leaman, Tramposch, Osborne, & Liss, 2017; social networking sites: Buglass, Binder, Betts, & Underwood, 2017; Facebook specifically: Beyens, Frisen, & Eggermont, 2016; Instagram: Barry, Reiter, Anderson, Schoessler, & Sidoti, 2017) thereby rather neglecting the device which 'contains' all these services. However, it is the entity of the smartphone which needs to be handled, touched and interacted with. This one-sided focus on features and applications, without considering the device itself as the entity the users interact with, is the starting point of our study. Thus, we focus on the device and refer to the idea of "computers as social actors" (Reeves & Nass, 1996) to analyze the users' relationship with their smartphones and to ask if this relationship constitutes a 'digital companionship'. Further, we ask if basic constituting characteristics of human relationships can be applied to the smartphone relationship. To find answers we (1) adapt measures originally applied to human interaction partners to the context of the smartphone. Additionally, (2) a new instrument labeled POD (Positioning Others and Devices) is developed and tested. (3) Measures are used to test a multivariate model that integrates core aspects of the 'digital companionship' with our smartphone with some of the fundamental psychological outcomes of relationships.

## 1.1 Smartphones equal real life: The paradigm of 'computers as social agents'

The basic idea of the present work, to focus on the device and to conceptualize it as an entity eliciting psychological responses, is not new. In the 1990s, Clifford Nass and collaborators introduced a research paradigm under the label CASA (Computers As Social Agents) which was based on an individuals' tendency to unintentionally apply social rules and norms to computers, leading to behaviors originally identified in social psychology for human-human interaction (for an overview: Reeves & Nass, 1996). To explain this tendency, Reeves and Nass (1996, p. 5) introduced the concept of media equation which briefly says that "media equals real life" triggering social reaction in the human user. Because the medium seems to communicate with us we unconsciously react in a way we react as if it was a human being, adopting social rules and norms, for example. As the process is rather unconscious it requires only low active mental involvement (Langer, 1989) resulting in media equation to be universal and almost unavoidable: it "applies to everyone, it applies often, and is highly consequential" (Reeves & Nass, 1996, p. 5).

Research referring to the idea of media equation transfers the social dynamics of human-human interaction to human-computer interaction. The studies conducted so far followed a similar approach: the human counterpart of human-human interaction was replaced by a media device to see if the same social rules are applied (Johnson, Gardner, & Wiles, 2004). As this research was mainly conducted more than 20 years ago, it focused on desktop personal computers (PCs). Compared to the mobile technologies of today, these computers were huge boxes and cathode ray tube screens, seldom moved, commonly turned on for use and turned off afterwards. Nevertheless, Nass and colleagues revealed this rather bulky equipment to be socially relevant. Summarizing their paradigm, desktop PCs send (allegedly) social cues which trigger automatic (non-conscious) social behavior in their users, following gender stereotypical tendencies, for example (Lee, Nass, & Brave, 2000; Nass, Steuer, & Tauber, 1994). To account for the findings under the CASA paradigm, Reeves and Nass (1996) argue from an evolutionary perspective. Accordingly, the human brain and its functional principles are considered as a product of evolutionary adaptation with the adaption not referring to today's challenges, but to the problems of survival and reproduction our ancestors were confronted with. In our ancestors' world, social interactions and the processing of social information were essential for both survival (e.g., co-operations with others) and reproduction (e.g., favorable mate selection). Consequently, the human mind is adapted to efficiently process complex social (human) stimuli with 'evolved psychological mechanisms' deeply rooted in human functioning (see also Buss, 2015). In contrast to our ancestors' world, in which entities sending these social cues were actual human (or at least living) beings, today's media or electronic devices send similar signals (e.g., by talking to us). Following the basic assumptions of media equation, these non-human signals lead to the illusion of intentional social interactions and trigger the mechanisms originally evolved for a human context (Reeves & Nass, 1996).

Compared to the equipment of the 1990s, modern smartphones should meet requirements of a 'social actor' to an even greater extent: ubiquitous in everyday life, they offer more varied opportunities of interactions and a multitude of cues (vocal and visual signals, sounds, vibrations, notifications). Consequently, current CASA studies consider smartphones to be the successor of desktop computers. Carolus, Schmidt, Schneider, Mayr and Muench (2018) revealed the norm of politeness to be transferred to a smartphone interaction. In a laboratory experiment, participants interacted with a smartphone which they evaluated, afterwards. To do so, participants used either the target phone itself, another given smartphone or their own smartphone. Results showed that their evaluations were significantly better if the target phone itself asked for these. Further, when using their own phone, participants' reported closeness to their phone was shown to be significantly negatively associated with the evaluation of the target phone. In another study by Carolus, Schmidt, Muench, Mayer, and Schneider (2018), participants interacted with a phone presented either in a blue or a pink sleeve, corresponding to the stereotype of gender-specific colors which links blue to masculinity and pink to femininity (e.g., Cunningham & Macrae, 2011). Participants were instructed to solve five social dilemmas with the phone always arguing for one of two options given and the pink and the blue phone "acting" completely identically. When asked to rate the femininity and the masculinity of the phone, participants ascribed significantly more masculine attributes to the blue sleeved smartphone and more female attributes to the pink phone.

Further, the blue phone was rated to be more competent and participants followed its advice significantly more often compared to the pink sleeved smartphone.

In line with these studies, the present study adopts the perspective on the smartphone as a 'social entity'. Specifically, we refer to these social entities, constantly in touch with their users and constantly interacting with them, as digital companions. The concept of digital companionship, we argue, provides a heuristically fruitful approach because it builds immediate links to the psychological research tradition on human-human relationships. Investigating digital companionship requires to consider both theoretical and methodological approaches established for human relationships and to transfer them to the postulated human-smartphone relationship.

## 1.2 Being in a relationship with one's smartphone: Basic characteristics and outcomes

The metaphor of smartphone companionship allows for drawing on theoretical concepts of the constituting characteristics and qualities of human relationship. Various approaches for analyzing interpersonal relationships have yielded a variety of concepts and variables to characterize them. To find a first starting point for insights into the postulated smartphone-relationship, we concentrate on a few robust and basic aspects constituting relationships. As before, we argue from the viewpoint of evolutionary psychology and the postulated basics of social bonding and relating to make a selection.

In our ancestors' world, social networks consisting of durable social relationships have been essential for our survival and reproduction (Dunbar, 1998). Core criteria of human belonging can therefore be assumed to be rooted in evolution. A basic human need for affiliation motivates us to seek encounters, attachment and bonding with other human beings. An increased frequency of interaction over a longer time facilitates relationship building and translates into how people think and feel about a relationship: Shared activities have been shown to predict intense love in the context of long-term romantic relationships (Acevedo & Aron, 2009; Kelley et al., 2002). Spatial closeness as well as emotional closeness are both a precondition and a result of interpersonal bonding that affect us on an emotional, cognitive as well as behavioral level (Binder, Roberts, & Sutcliffe, 2012; Bowlby, 1988). Perceptions of closeness have repeatedly been linked to intimacy, affection and affirmation regarding relationships (Perlman & Fehr, 1987; Sinclair & Dowdy, 2005). Closeness, therefore, is the first constituent aspect of companionship selected here.

Next to closeness, there are more concepts that can indicate reliable relationship. Individuals will rely and focus most on those relationships that they find trustworthy. In close relationships, partners' mutual trust has been closely linked to taking care for each other (Rempel, Holmes, & Zanna, 1985). In earlier work, Driscoll, Davis, and Lipetz (1972) emphasize that trust is the outcome of mutually satisfying interactions. Indeed, durability and trustworthiness can be defined along very similar lines. Following Holmes and Rempel (1989), trust includes three dimensions: (1) predictability in terms of the partner behaving consistently, (2) dependability in terms of the partner to be reliable and

benevolent and (3) faith in terms of the partner to be responsive and caring. Trust can therefore be added to closeness for a core description of companionship.

If social interaction is reflected in trust and closeness, this implies further orientation and alertness towards the relationship partner. Research focusing on long-term romantic relationships revealed interaction, but also reported preoccupation with the partner in terms of positive thoughts about each other, to be a significant predictor of love and being together for a long time (Acevedo & Aron, 2009; Kelley et al., 2002). Other work shows closeness and trust in intimate relationships to occur together with the sharing of personal information and feelings, and links such preoccupation with the other person to wellbeing (Perlman & Fehr, 1987). Preoccupation is therefore used as the third core constituent of companionship.

Next to a conceptualization of companionship, the consequences of maintaining such a companionship are also of obvious interest. In line with the tenet that close relationships are evolutionarily beneficial, relationships have been associated with psychological benefits such as positive effects on the individual's well-being, constituting a buffer against other stressors (Walen & Lachman, 2000) and a contributor to coping in general (Rini, Schetter, Hobel, Glynn, & Sandman, 2006). However, human relationships are also discussed in terms of their negative outcomes revealing stress, for example (Christensen & Heavey, 1990). Interpersonal stressors such as conflicts in social relationship were found to have a greater impact on the mood than job-related stressors (Bolger, DeLongis, Kessler, & Schilling, 1989) resulting in adverse health outcomes (Robles & Kiecolt-Glaser, 2003). Conflicts within the family or with the partner, controversies or health issues are major stressors.

Although only a partial aspect of relationships can be considered in the present work, there is good evidence to support an initial selection of closeness, preoccupation and trust as core aspects of meaningful relationships as well as both stress and coping with stress as immediate relationship outcomes. In a next step, these variables are related to each other in a testable model of human-smartphone companionship.

## 1.3 A theoretical model of core characteristics of digital companionship and its outcomes

The basic characteristics and outcomes of human-human relationships introduced so far are transferred to the postulated human-phone relationship and integrated into a model. Hence, we propose a model of 'digital companionship' which integrates (1) smartphone-user psychological closeness, trust and preoccupation and the outcomes (2) stress caused by the smartphone as well as smartphone usage to cope with stress. It seems plausible to assume a causal flow from relationship core constituents to outcomes. Put differently, we see closeness, preoccupation and trust as directly indicating digital companionship and this companionship to affect coping and stress. However, to clearly assign causal relationships among closeness, preoccupation and trust and the distinct effects on coping and stress is more difficult. Referring to the wider literature on interpersonal

relationships, however, allows for some tentative conclusions and the postulation of a testable model. Such a model will be, by necessity, open to further modification and refinements.

As becomes clear from the discussion so far, studies have shown that the core aspects of companionship show overlap and mutual associations in several places (see, e.g., Perlman & Fehr, 1987, p. 17). However, closeness is generally depicted to resemble a rather broad attitudinal variable referring to the process of bonding. Further, preoccupation typically concerns the cognitive as well as the affective engagement with one's partner, and trust concerns more elaborate expectations and beliefs regarding partner behaviors. Both these variables therefore are seen to build up during longer-term processes and to relate to more elaborate and/or specific processing. Consequently, they might be conceptualized as a result of closeness. In our further theorizing, we will therefore emphasize a sequence from closeness to trust and further to preoccupation, without detailing other possible causal dependencies for the moment.

Finally, stress and coping with it are regarded as outcomes generated by companionship and are therefore expected to be positively associated with trust and preoccupation. As outlined, research has revealed social relationships to be fundamentally important for coping with stress. Thus, we transfer this finding to the smartphone-relationship. However, research has also shown that social relations do elicit stress. Being close to another person you trust and think about often can easily turn into a source of stress across a range of situations. It is likely that both outcomes are related to each other in turn, but the exact nature of such a relationship is challenging to determine a priori. It could be that the nature of the relationships leads to the predominance of either stress or coping, which would mean a negative association. It could also be that more intense relationships simply generate more experiences of both stress and coping, in which case the association would be positive. This is a point which is left to empirical testing.

In sum, the resulting model, shown in Figure 1, is far away from being an exhaustive conceptualization of digital companionship. However, it allows for important first steps towards empirical tests of the basic idea. The empirical testing will result in first insights into the relationship and first derivations regarding refinements and adjustments for future research.

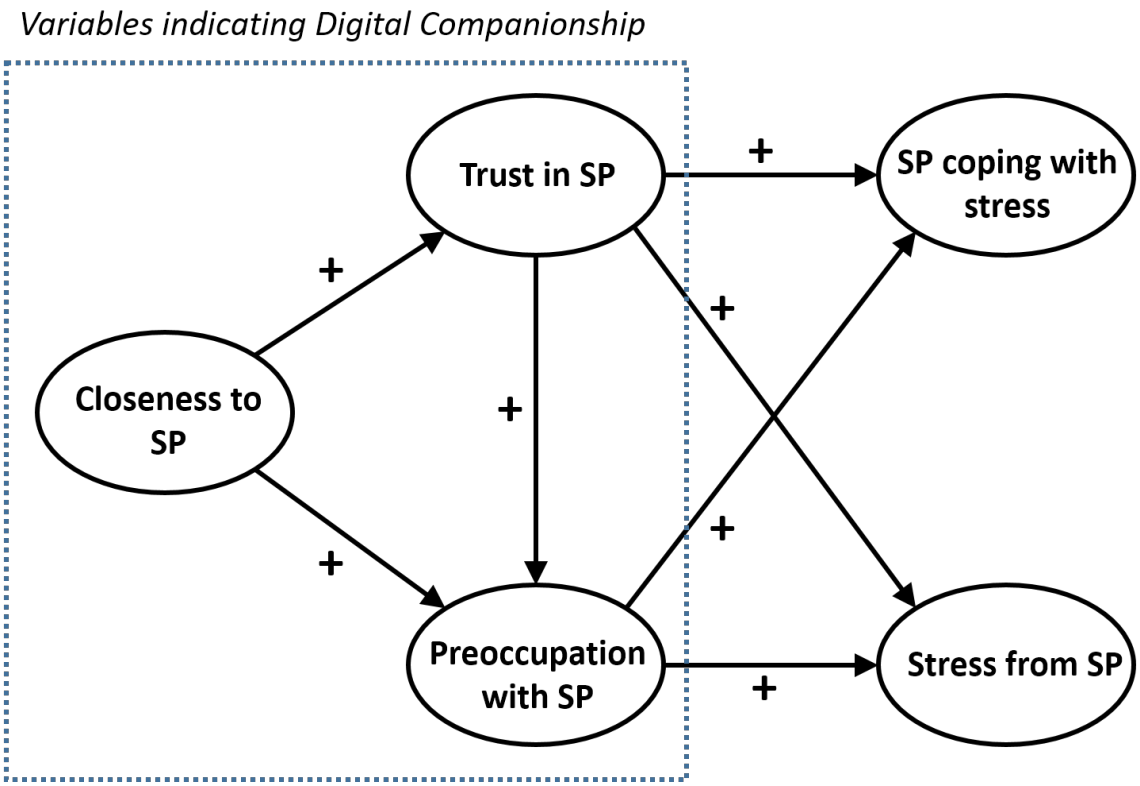


*Figure 1*. Variables Indicating Digital Companionship and Their Postulated Associations

In the following, we report two sets of results from a survey-based study which aims for the development of a new measure to assess users' closeness to their smartphones by locating the smartphone relative to other devices as well as socially relevant persons, first. Second, the study aims for the transfer of measures assessing human-human-relationship to the field of smartphone relationship, and, thirdly, to test the postulated theoretical model by adopting the outcomes of both the newly developed task as well as the transferred measures.

# 2. Method

## 2.1 Sample

To correspond to the wide-spread distribution of smartphones in Western populations, this study aimed for an increased sample diversity to go beyond university-based settings. To increase heterogeneity regarding age, education and nationality, participants were recruited online via advertisements posted on social media platforms (facebook, ebay) in Germany and in the UK. A total of 1156 participants completed either the German (n = 890) or the English version (n = 266) of the survey. Participants ranged in age from 15 to 83 years (M = 28.39 years, SD = 8.98), with 67% female respondents. In terms of occupation, 55% reported to be a student in higher education, 31% to be employed, 4% to be self-employed, 3% to be in training, 3% to be unemployed, 2% to be school students,

1% to be retired or in the civil service. Additionally, 51% of participants reported to be in a relationship, 12% to be married, 35% to be single, 2% divorced and < 1% widowed. Statistics of phone use revealed an average use of the mobile phone for M = 11.12 years (SD = 4.98). The two biggest user groups were for Apple (37%) and Samsung (31%) products with all other brands showing ownership rates of less than 7%. On average, participants reported to use their smartphone 4.29 hours (SD = 3.74) a day (work purposes: 1.37 hours, SD = 1.96; spare time activities: 2.94 hours; SD = 2.55).

## 2.2 Procedure and measures

The online survey study was optimized for use on desktop computers and mobile devices. The front page briefly instructed about the broad purpose of the study with the procedure following the ethical guidelines laid out by the German Psychological Association and the British Psychological Society. The study had been approved by an institutional review board at the UK project site prior to data collection, which satisfied requirements at the German project site. Smartphone possession was implemented as a screening criterion, resulting in a sample of participants reporting to have a smartphone. After completion of the survey participants were offered the opportunity to anonymously enter a prize draw to win online vouchers.

### 2.2.1 Questionnaire measures: trust, preoccupation, coping and stress

To assess the variables introduced in the theoretical model self-report measures were used. For trust, preoccupation, stress and coping, standard questionnaire items were answered on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). To assess the users' closeness to their phones a new instrument was developed.

*Trust in phone*. The Trust in Close Relationships Scale (Rempel et al., 1985) measures levels of trust in one's relationship partner on three dimensions, predictability, dependability and faith. For the present study, the items were adapted to the context of smartphone usage by replacing the word 'partner' in the items with 'mobile phone', first. However, this transfer did not always result in sensible and applicable statements or items. Regarding the subdimension faith, no items could be transferred to the context of mobile use in an appropriate way (e.g., 'When I share my problems with my mobile, I know it will respond in a loving way even before I say anything.'). Consequently, we excluded the subdimension. Transfer of items capturing the two other subdimensions worked out better, although not without inviting contradiction. In rational terms, a smartphone is not a responsive recipient of trust in a way known from human-human interactions. However, to pursue the idea of the postulated digital companionship as far as possible we retained items despite any logical inconsistencies. All five predictability items were therefore adapted as described without further changes (e.g., 'My mobile behaves in a very consistent manner.'; 'I sometimes avoid my mobile because it is unpredictable and I fear saying or doing something which might create conflict.'). Regarding the dependability subdimension, two out of five items needed further modification to result in appropriate statements ('My mobile has proven to be trustworthy and I am willing to let it engage in activities which other mobiles find too threatening' was rephrased to 'My mobile has proven to be trustworthy.'; 'I am certain that my mobile would not cheat on me, even if the opportunity arose and there was no chance that it

would get caught.' resulted in 'I am certain that my mobile would not cheat on me.'). The other three items were transferred in their full wording (e.g., 'I can rely on my mobile to keep the promises it makes to me.'). In sum, the Trust in phone scale consisted of ten items with an internal consistency of α = .76. Closer inspection showed the dependability items to be internally more consistent (.85) than the predictability items (.52). Following Nunnally's (1967) suggestion to accept α-values between 0.5 and 0.6 when developing new scales, and in light of the overall consistency, we kept all ten items. Items were averaged such that higher values indicated higher levels of trust.

*Preoccupation with phone.* The eight-item Mobile Phone Involvement Questionnaire (MPIQ) developed by Walsh, White, Cox and Young (2011) originally refers to components of behavioral addiction (Brown, 1997; Walsh, White & Young, 2008), for example, withdrawal symptoms, cognitive and behavioral salience, relapse and involvement reinstatement. However, Walsh et al. (2011) avoided the term addiction. Their less pathologizing label 'involvement' refers to the respondents' cognitive and behavioral association with their mobile phone which corresponds to a 'preoccupation with the phone' as stressed in the present study. Thus, all eight MPIQ items were employed (e.g., 'I often think about my mobile phone when I am not using it' and 'The thought of being without my smartphone makes me feel distressed'). Internal consistency of the scale was α = .85. Items were averaged such that higher values indicated higher levels of preoccupation.

*Coping with stress through phone use.* As with items regarding trust, an index of coping, in terms of dealing with stressful situations by using your mobile phone, was developed by modifying items originally used for the assessment of coping in general (Satow, 2012). The different mechanisms for coping by either actively managing stress (e.g., prevention), relying on social support (e.g., friend) or distracting oneself from stressful situations (e.g., alcohol) were replaced with the term 'my mobile'. Hence, three out of five subscales could be transferred to the context of smartphones (active coping with stress, social support, increased alcohol and cigarette consumption). To these, an item 'My mobile helps me to cope with stress.' was added. The final instrument comprised of 13 items with an internal consistency of α = .87. Items were averaged such that higher values indicated higher levels of coping.

*Stress caused by the phone.* In contrast to the measures of trust and coping the items for assessing stress needed to be newly developed due to lack of an appropriate template. To complement the items of coping which ask for ways of usage to cope with stress, we developed items asking for situations of usage the individual is stressed by the phone. In a preliminary study, we asked 86 participants 'When does your smartphone cause stress?'. Answers were content analyzed resulting in 23 items, for example: 'I find it stressful when my mobile or an app does not work.' or 'I find it stressful when I have lots of messages I have not replied to.' Internal consistency of the scale was α = .93. Items were averaged such that higher values indicated higher levels of stress.

### 2.2.2 POD - Positioning Others and Devices: A two-dimensional token technique

Central to our view on smartphones as digital companions is the assumption of the owner emotionally attached or feeling emotionally close to the phone. Thus, we developed an online instrument (labeled POD: Positioning Others and Devices) to assess the closeness in terms of emotional importance of the smartphone. POD builds on a technique known from systemic family therapy. Gehring, Funk, and Schneider (1998) developed the 'Familiensystem-Test' (family system test; FAST) which psychotherapists can use to visualize cohesion and hierarchy within the family. In this offline procedure, pieces which represent family members are positioned on a board. The pieces are similar to pieces known from board games: cylindric, with painted nose and eyes to indicate a face. The board is similar to a chess board, but measures 9 by 9 fields. The distance between the pieces put on the board is interpreted as interpersonal cohesion among family members, ranging from neighboring fields (maximum cohesion) to fields being at opposite ends of the board (minimum cohesion). Further, the pieces can be raised, to visualize hierarchy, and turned, to indicate direction of view and attention. Clients are instructed to visualize their own family in terms of a typical, an ideal and a conflict situation by positioning pieces on the board. The resulting visualizations are used to further analyze client perceptions of relationship structures.

We adopted the basic idea of the original FAST version. However, we did not only ask for family members but for a wider range of (1) relevant others and (2) media devices. Both the relevant others as well as relevant devices were collected in a preliminary study in which participants (n = 79) were asked to list 'significant others they know' as well as 'media devices they use'. 15 significant others (parents, siblings, children, partner etc.) and 10 media devices (mobile, tv, laptop, radio etc.) were derived. In the final POD, participants were asked to position pieces representing these persons and devices in relation to a piece representing themselves ('me') on a grid. To do so, the categories of relevant others were presented in a first step and participants were instructed to 'provide the name of one specific person of your social environment' for every category. If they could not think of any specific person, the category was left blank. Second, the list of devices was presented, and participants were instructed to 'select all media devices you have yourself or that you use regularly'. Third, a 9 x 9 grid was presented together with an icon representing 'me' next to it. Participants were asked to position 'the piece representing yourself [...] on the chess board'. In this, we followed the original FAST instruction which did not limit the positioning of the 'me-piece' to a certain area or a certain field of the board. Fourth, icons representing the people and devices selected before were presented next to the grid with the 'me-piece' on it. Participants were requested to position these other pieces to indicate 'how important these people and devices are' with the added information that 'the more distance there is between your own piece and that of another person/device the less importance this person/device carries'. Importance, rather than closeness, was used in the instructions to avoid any ambiguities arising from the two meanings of closeness, as distance and as emotional relevance, on the respondent's side. Otherwise, respondents could have switched between meanings when placing others and devices. This means that POD relies on participants interpreting 'importance of others' in the same way as 'importance of devices', a point we revisit in the discussion.

Figure 2 illustrates the positioning task of the POD. Afterwards, distances between the pieces were calculated with Euclidean distances ranging, on a 9x9 board,

from 1 (neighboring space) to 11.31 (two pieces occupying the endpoints of one of the diagonals).[1] To assess the participant's closeness to the smartphone an index of four distances was calculated: (a) the self-phone distance (M = 2.42, SD = 1.37), (b) the self-phone distance minus the average distance to family members (M = 0.62, SD = 1.57), (c) the self-phone distance minus the average distance to others who are not family members (M = -0.93, SD = 1.80), (d) the self-phone distance minus the average distance to devices (M = -1.02, SD = 1.29). Taken together, these indicators capture an individual's closeness to the phone relative to the closeness to significant others as well as other devices. To form a POD score, all four variables were averaged with an internal consistency of $\alpha = .86$. This composite score was highly correlated with self-phone distance ($r = .91$, $p < .001$). Note that due to the nature of the POD task, higher values always indicate greater distance rather than closeness.

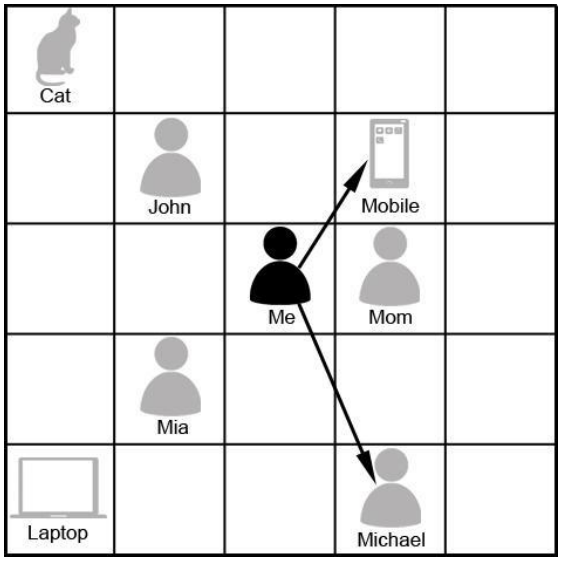


*Figure 2*. Illustration of the positioning of significant persons and media devices in relation to 'me-piece'

# 3. Results

Two main goals are pursued in the presentation of results. First, the results of the POD will be presented offering a new methodological approach of assessment of users' closeness to their smartphones. Second, the theoretical model (Figure 1) will be tested by means of structural equation modelling to gain insights into the postulated digital companionship and its outcomes regarding smartphone-related stress and coping.

## 3.1 Preliminary analyses

A summary of mean scores and standard deviations for all variables used in data modelling are shown in Table 1. The POD score is the average of the four variables representing the self-phone distance in relation to the distance reported for other social actors.

Table 1

*Mean Scores and Standard Deviations for All Variables*

| Variable | Mean | *SD* | Min | Max | Scale |
|---|---|---|---|---|---|
| Phone Use | 4.23 | 3.74 | 0 | 20 | hours/day |
| POD Score | 0.46 | 1.24 | -3.01 | 8.21 | spatial distance* |
| Trust | 4.31 | 0.84 | 1.33 | 7 | 1-7 |
| Preoccupation | 3.37 | 1.24 | 1 | 7 | 1-7 |
| Coping | 3.02 | 1.13 | 1 | 7 | 1-7 |
| Stress | 3.64 | 1.16 | 1 | 7 | 1-7 |

*Notes*. *lower values indicate greater closeness

Intercorrelations of the scales as well as age and gender are summarized in Table 2. Gender was coded 1 (“male”) and 2 (“female”) for the analyses. Both the time spent on phone use and the demographic variables showed several significant associations with the variables that are part of the theoretical model (Figure 1). Coefficients tended to be low, however, not exceeding |.32|, and did not explain substantial portions of variance in the other variables. It was decided, therefore, to control for age, gender and phone use in the multivariate modelling reported in section 3.3.

Table 2

*Intercorrelations for All Variables Postulated in the Theoretical Model, Age, Gender and Phone Use.*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1 – Gender | - | .00 | .00 | -.03 | -.07* | -.03 | -.06* | .02 |
| 2 – Age | | - | -.11** | .00 | -.02 | -.24** | -.11** | -.17** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 – Phone Use | - | -.17** | .13** | .32** | .23** | .17** |
| 4 – POD Score | | - | -.14** | -.34** | -.26** | -.22** |
| 5 – Trust | | | - | .19** | .20** | .06* |
| 6 – Preoccupation | | | | - | .50** | .57** |
| 7 – Coping | | | | | - | .53** |
| 8 – Stress | | | | | | - |

*Notes.* *: $p < .05$; **: $p < .001$. Gender was coded 1 (“male”) and 2 (“female”).

## 3.2 Closeness to the smartphone: Results of the POD

POD visualizes the participant’s closeness to media devices and persons by spatial distances on a grid. The POD index derived from the procedure relates closeness to one’s phone with closeness to other devices and closeness to relevant family members as well as relevant others. First, to approve basic functionality of this procedure, POD positions were checked for plausibility. Regarding relevant persons, lower scores (min. 1.00) indicating closer relationships were expected for intimate human relationships (partner, family, friends) and higher scores (max. 11.31) for supposedly less relevant persons (neighbors, work colleagues, sports team mates). To give an overview, Figure 3 shows the mean distances for the persons and devices at least one third of participants reported to be relevant and therefore positioned on the chess board. Note that with respect to the possible range of POD (1 to 11.31) the resulting values are rather low. This is a consequence of 33.6 % of the sample positioning the piece representing ‘me’ on the central position of the board. In those cases, all possible distances to self were confined to a range from 1 to 5.66.

As can be expected, POD reveals partner and family members to be the closest to ‘me’: partner ($M = 1.32$, $SD = 1.04$), parents ($M = 1.52$, $SD = 1.02$), and siblings ($M = 1.71$, $SD = 1.16$). At the same time, and equally plausibly, media devices are on average less close to ‘me’: smartphone ($M = 2.42$, $SD = 1.37$), laptop ($M = 2.76$, $SD = 1.45$), and computer ($M = 3.12$, $SD = 1.74$). For further statistical comparison, t-tests for partially overlapping samples, following the approach by Derrick, Russ, Toher, and White (2017), were conducted on the series of three closest social actors and three closest media devices by comparing each mean score with the next highest. All these comparisons were significant with $p$s $< .001$ and t-values ranging in between $t(858.18) = 4.38$ (partner-

parents) and $t(1078.73) = 13.49$ (siblings-smartphone). Tests for partially overlapping samples reflect the fact that only the smartphone and the piece representing self were used by all participants.[2] In additional t-tests, positioning of the smartphone was compared to that of the neighboring social actors as displayed in Figure 3. The smartphone ($M = 2.42$, $SD = 1.37$) was at a greater distance from self than grandparents ($M = 2.21$, $SD = 1.34$, $t(933.39) = 3.33$, $p < .001$), level with relatives ($M = 2.37$, $SD = 1.22$, $t(935.34) = 0.80$, $p = .43$), and closer than flatmates ($M = 2.72$, $SD = 1.63$, $t(520.61) = 3.50$, $p < .001$) and classmates ($M = 2.90$, $SD = 1.47$ $t(593.84) = 6.16$, $p < .001$).

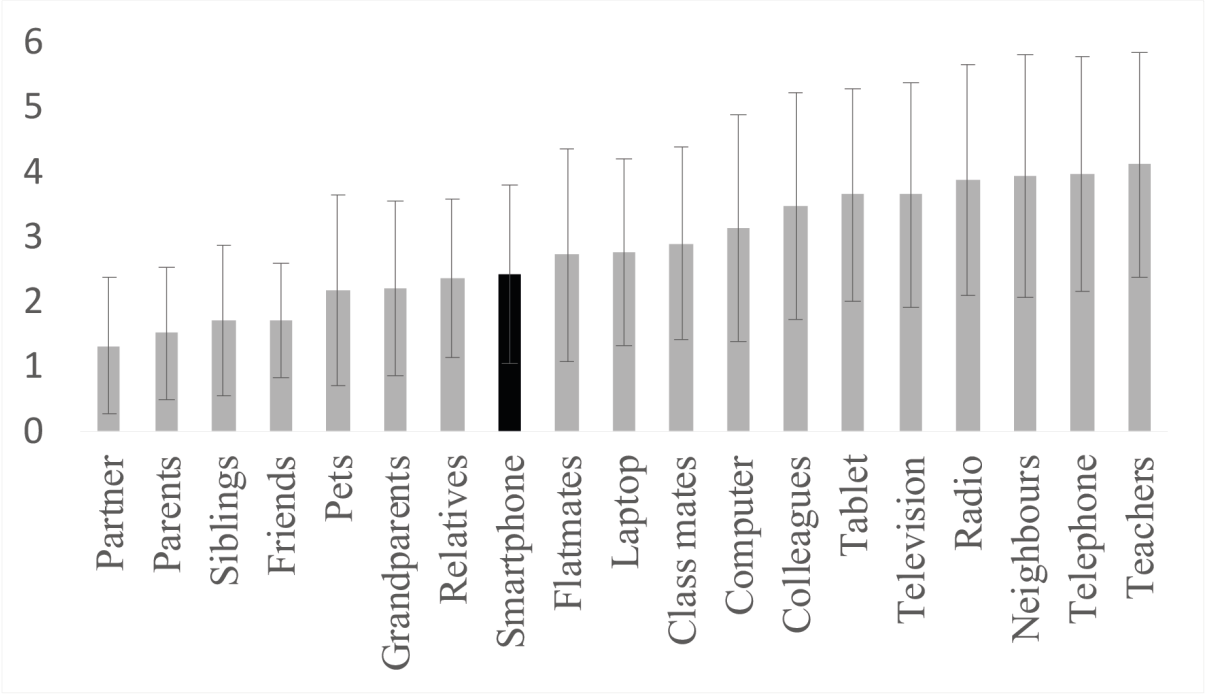


*Figure 3*. Ranking for POD mean distances between 'me' and persons and devices

In sum, referring to the underlying assumption of smartphones being digital companions, POD reveals smartphones to be (1) the most relevant device as they are positioned closer to 'me' than all the other listed devices. On average, (2) regarding overall closeness, smartphones are on rank eight among all frequently used categories (see Figure 3), closer than any other media device and closer than several humans. Out of all respondents, 21.2% of those reporting on both their partner and their smartphone rated the phone as closer than their partner. For parents and siblings, the corresponding values were 29.4% and 35.3%, respectively. Note that POD simply asks for 'the importance' of the devices/humans, but not for the valence of the relationships, their functionality or dysfunctionality, for example.

## 3.3 Structural equation modeling: Multivariate analyses of postulated digital companionship

A sequential strategy was pursued for structural equation modelling. First, confirmatory factor analyses (CFA) were carried out on each individual construct in the model - POD

score, trust, preoccupation, coping and stress - in order to ascertain sufficient homogeneity of indicators. CFA outcomes were then used to create parcels of indicators for trust, preoccupation, coping and stress following the recommendations given by Kenny (2014). This was done to ensure that the number of parameters to be estimated was appropriate to the sample size. Specifically, for each construct with five or more indicators, indicators were averaged to form a smaller number of parcels based on factorial structures obtained in the CFA. Where CFA outcomes supported a uni-factorial construct, indicators were distributed sequentially over parcels.

For stress, all 23 items were retained and were distributed sequentially over four parcels based on decreasing CFA loadings. For trust, the two subscales, predictability and dependability, provided two parcels each resulting in four indicators. For coping, four parcels were created using 12 out of 13 scale items. One item ('No matter how great the stress I would never turn to my mobile because of stress.') was removed due to poor factor loading. For preoccupation, all eight items were retained and sequentially distributed over four parcels. All final parceling solutions yielded acceptable fit indices over a range of model fit measures ($\chi^2$, CFI, TLI, RMSEA) with the solution for preoccupation showing the lowest fit: $\chi^2(2) = 16.16$, $p < .001$, CFI = .99, TLI = .98, RMSEA = .08 [.05; .12]. No parceling was applied to the POD score which remained based on the four indicators outlined previously. Although model fit for POD was somewhat inferior to that of the parceled scales ($\chi^2(1) = 18.98$, $p < .001$, CFI = .99, TLI = .93, RMSEA = .13 [.08; .18]), it was decided to keep all four indicators given their face validity and their high internal consistency ($\alpha = .86$). Overall, then, each construct was represented by four indicators: the four indices derived from POD data and four parcels each for trust, preoccupation, coping and stress.

In a next step, the associations postulated in the theoretical model (see Figure 1) were specified in a comprehensive structural model. Full information maximum likelihood (FIML) estimation was used in AMOS 24. This was done to ensure that the full data set could be used since the response patterns in the POD led to missing values: if participants did not use all available pieces (e.g., because they did not own a particular device or did not relate to a type of social actor the POD suggested) this meant that they did not indicate closeness for all of the pre-defined categories. As outlined previously (see Section 3.1), age, gender and phone use were always controlled for by postulating direct paths from all control variables to all constructs. This was done so that path coefficients in the postulated model could be interpreted as being independent of demographics and total phone exposure. At the same time, the procedure allowed for an exploration of the direct effects of user characteristics. Considering modification indices and the same range of model fit measures used for the CFAs, very minor modifications were applied to the empirical model. In particular, stress and coping were set to co-vary, which was in line with our initial considerations of the possible association between these two relationship outcomes. Further, additional paths were included from closeness to stress and coping. This was deemed necessary to allow for a comparison of direct and indirect effects from closeness to stress and coping, although our postulated model did not rely on direct effects to emerge (see Figure 1). The resulting model showed good model fit ($\chi^2(203) = 789.50$ ($p < .001$), CFI = .96, TLI = .95, RMSEA = .05 [.046; .054]) and is summarized in Figure 4 and Table 3.

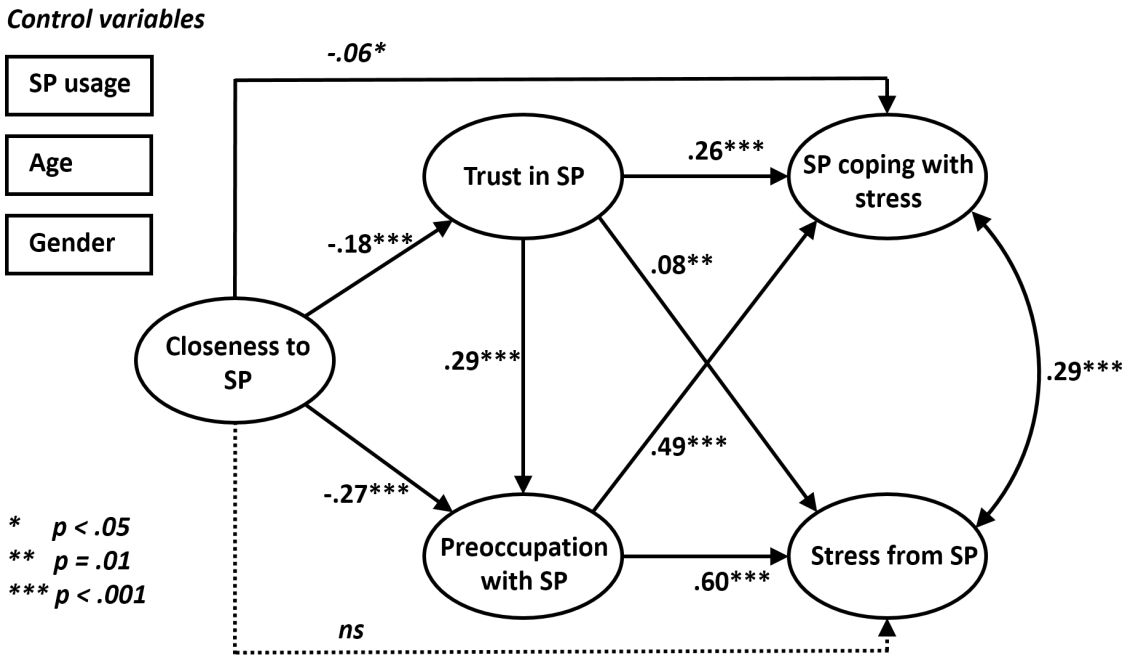


*Figure 4*. Structural Model for Digital Companionship, Stress and Coping, with Phone Usage, Age and Gender as Control Variables. Standardized coefficients are displayed. All control variables are connected to all latent variables via direct paths (reported separately in Table 3).

A comparison of Figure 1 and Figure 4 shows close correspondence between the theoretical and the empirical model. As postulated, closeness to one's smartphone was positively related to both trust in the phone and preoccupation with the phone. Further, the relationship between smartphone closeness and stress was fully mediated by trust and preoccupation. Closeness had a non-significant direct effect on stress (β = -.02, $p$ = .46), and a significant indirect effect, via trust and preoccupation of β = -.21. The relationship between smartphone closeness and coping was partially mediated by trust and preoccupation. Closeness had a small direct effect on coping (β = -.06, $p$ = .04), in comparison to the indirect effect of β = -.21. Total effects for closeness on stress and coping were close to the indirect effects: β = -.23 and β = -.26, respectively.[3]

Trust, in turn, showed both direct and indirect effects on stress and coping. The direct effect of trust on stress was small but significant (β = .08, $p$ = .01) while the indirect effect on stress, via preoccupation, was β = .17. In comparison, the direct effect of trust on coping was β = .26, and the indirect effect, again via preoccupation, was β = .14. Total effects for trust on stress and coping were β = .25 and β = .40, respectively.

Table 3

*Standardised Coefficients For User Characteristics*

| User Variables | Closeness | Trust | Pre-occupation | Stress | Coping |
|---|---|---|---|---|---|
| Age | -.04 | *-.13* | *-.20* | -.02 | -.01 |
| | (.25) | (<.001) | (<.001) | (.53) | (.84) |
| Gender | -.03 | *-.12* | *.06* | .01 | .00 |
| | (.33) | (<.001) | (.03) | (.72) | (.95) |
| SP Usage | *-.18* | *.13* | *.23* | *-.07* | .03 |
| | (<.001) | (<.001) | (<.001) | (.01) | (.31) |

*Notes*. p-values are in parentheses. Significant coefficients are displayed in italics. For associations with the exogeneous variable Closeness, correlations are reported, path coefficients otherwise.

When it comes to user characteristics, several associations emerged between age, gender, level of smartphone use and those variables that define digital companionship, i.e., closeness, trust and preoccupation (see Table 3). Older participants tended to report lower levels of trust ($\beta = -.13$, $p < .001$) and preoccupation ($\beta = -.20$, $p < .001$), although closeness did not show any significant association with age. Females reported altogether lower levels of trust ($\beta = -.12$, $p < .001$) and higher levels of preoccupation ($\beta = .06$, $p = .03$) compared to males. No gender differences were found for closeness. Higher levels of smartphone usage were plausibly associated with more closeness ($r = -.18$, $p < .001$), higher levels of trust ($\beta = .13$, $p < .001$) and higher levels of preoccupation ($\beta = .23$, $p < .001$). In contrast, relationship outcomes were less obviously related to user characteristics. Only the level of smartphone usage showed a significant negative association with stress ($\beta = -.07$, $p = .01$), indicating that more experienced users reported lower levels of stress.

Finally, a multi-group comparison was carried out to investigate model robustness across the two language versions of the study. Compared to the comprehensive, one-group model, fit improved slightly on some indicators when parameters were allowed to vary across language ($\chi^2(376) = 1013.93$ ($p < .001$), CFI = .96, TLI = .94, RMSEA = .04 [.036; .041]). The improvement, however, was deemed not very substantial considering high similarity of sub-sample models. It was therefore concluded that a comprehensive model represented the data best.

# 4. Discussion

The current study conceptualizes users to be in a relationship with their smartphones, termed ‘digital companionship’. Starting out with the omnipresence of smartphones, resulting from an increasing number of people worldwide using them for an increasing number of purposes and over increasing periods of time, we take up the approach of ‘computers as social agents’ from the 1990s, now amplified by the new dimension of smartphone usage and interactivity. Compared to human-computer-interaction in the past, today’s smartphone use sets new standards regarding duration and frequency of use as well as the range of underlying human needs being gratified. Conceptualizing the smartphone to be more than a mere technological device and to postulate a digital companionship is therefore regarded as a heuristically fruitful perspective. The empirical aims of the current work were threefold: to overcome the methodological challenge of assessing the relationship with a device in the same way as for conventional social relationships (and comparative to those) by (1) developing a new instrument and (2) transferring existing measures assessing human-human-relationship to the field of smartphone relationship. Further, our study aimed for (3) demonstrating that such companionship can be characterized in more detail by basic psychological constituents and outcomes of human relationships.

Regarding our first and our second aim, participants’ answering behavior for adapted items and scales suggested that they found little difficulty in following the idea of a human-smartphone relationship. Contrary to our apprehensions, participants seemed very accepting of items which transferred fundamentally human characteristics to the context of smartphones, often in rather unusual wording. Further, they followed the instructions of the POD and positioned the pieces representing persons and devices on the board. Scale reliabilities for the adapted measures for trust, preoccupation, stress and coping were all acceptable ranging from $\alpha = .76$ to $\alpha = .93$. Distributions of these variables uniformly had mean scores in the mid-third of the response scale (which ran from 1 to 7), with standard deviations not exceeding 1.5 scale points (see Table 1). This notwithstanding, some limitations are noteworthy. Simply answering items by rating statements on a Likert scale does not fully demonstrate that the content or the meaning of the items are understood as intended or deemed acceptable by the respondent. From the perspective of a quantitative research approach, a data collection free from complications together with interpretable statistical results both indicate a successful first investigation into the postulated digital companionship. Qualitative techniques, however, such as interviews and focus groups, may reveal further insights into the extent and nature of such companionship by allowing participants to choose their own words and descriptions (see, e.g., Fullwood, Quinn, Kaye, & Redding, 2017).

Further, during the process of scale and item development not all items or aspects of variables turned out to be transferable to human-smartphone interactions. In particular, we did not use the faith subscale of trust and were limited to the two subscales assessing dependability and predictability. Consequently, our measurement of “trust in phone” is limited compared to the measurement of trust in a human counterpart. Further studies may be needed to determine whether a more thorough re-wording of the faith sub-scale

would enhance the measure or whether the concept of faith itself is not transferable to the digital companionship. Thus, our recommendation would be to address the conceptualization of trust and of other variables by re-analyzing further quantitative measures and implementing qualitative approaches.

The newly developed POD constitutes a novel approach to consider and to refer to human-smartphone relationships, or indeed human-technology relationships more widely. The POD allows to visualize closeness to media devices and persons through spatial distances on a grid resulting in a modified version of a family constellation as used in psychotherapy (Gehring et al., 1989). An index derived from the procedure relates closeness to one's phone with closeness to other devices and closeness to relevant family members as well as relevant others. In sum, the descriptive statistics associated with the POD score revealed the smartphone to be the most important device compared to other devices. In addition, on average the smartphone was located in between participants' meaningful relationships and their more peripheral social contacts. Focusing on just the self-other distance in the POD, the phone was placed behind 'relatives' and before 'flat mates' resulting in the overall finding of the phone to constitute an important entity to their owners (see Figure 3).

Several improvements can now be suggested for further development and strengthening of the POD. In terms of mere technical aspects, the usability of the software tool employed can be improved, as well as its implementation within (online) studies and its options for analysis and presentation of outcomes. This is the subject of ongoing research. In methodological terms, the latent variable the POD postulates to assess needs careful consideration. We set up the POD to assess emotional closeness, such as occurs in social bonds. However, the current version asks for 'importance' due to anticipated ambiguities arising from the two meanings of closeness, as distance and as emotional relevance, on the respondent's side. This re-wording, obviously, poses the question whether an interpretation as 'closeness' is fully warranted. For example, a device which is important to me does not need to be emotionally close to me. The same holds for the assessment of social actors, although here the implicit association between closeness and importance can be deemed stronger. The general response patterns for devices and social actors obtained in the present study do not provide any strong indication that instructions were applied differently to both categories, but this point clearly merits further investigation. It could be addressed by analyzing different concepts of (emotional) relevance in a comparison of different versions of the POD.

Another comparison study would be useful for testing different restrictions for positioning the me-piece. In the present version of the POD, participants were instructed to place the 'me-piece' on any part of the grid without any constraints. Thus, the potential variability of the POD scores differed between participants who positioned the piece in the center or in the very corner of the board, for example. This set-up was chosen because we did not want to restrict the position in this very first attempt of the POD. It did not seem advisable, for example, to put participants automatically at the center for a task that was partly about outlining complex social constellations. As the results indicated substantial variability in the positioning of the me-piece, however, some fixed positioning should be further considered to enhance comparability across participants. In sum, the

present version of the POD demonstrates the usefulness of an instrument that captures emotional aspects of digital companionship more intuitively than questionnaires and, at the same time, highlights areas of continued methodological investigation.

Regarding our third aim, the transfer of basic characteristics and outcomes of human-human relationships to the human-phone relationship, empirical support was obtained for a model that links components of companionship to both positive (coping with stress) and negative (experiencing stress) outcomes of smartphone use. To capture some of the complexity of human relationships we postulated 'digital companionship' to be represented by emotional closeness, trust and preoccupation and smartphone-related stress and coping with stress to be directly affected by trust and preoccupation. This model was not intended as an exhaustive conceptualization of digital companionship, but rather as a working model suitable for empirical testing and for the integration of more variables. We are therefore cautious in assigning any exclusivity to the causal pathways implied by the model. Overall, structural equation modelling indicated a good fit between the data and the theoretical model. Some flexibility for model modification was deemed acceptable, but was limited to comparatively specific aspects of the model, not the overall arrangement of variables.

In our model, closeness to the smartphone has little direct bearing on stress and coping, but is mostly mediated by trust and preoccupation. In detail, preoccupation with the phone shows stronger, positive associations with stress and coping than trust - although part of the effects of trust are mediated via preoccupation. High levels of preoccupation here depict the smartphone as an omnipresent entity potentially affecting users' thoughts and behaviors, and the preoccupation measure used here (Walsh et al., 2011) shows some overlap with symptoms of addiction. Consequently, the stronger effect on stress seems plausible. However, the effect of preoccupation on coping with stress, by utilizing one's phone, is also substantial and highlights another important aspect of preoccupation. Being involved with the phone leads to stress, but it does also result in stress relief. Further, coping and stress turned out to be best represented in the model as positively associated with each other. This may simply reflect the fact that with increased levels of companionship human-smartphone interaction in general increases, which in turn gives rise to experiences of both stress and coping. From our point of view, the main benefit of assessing both types of outcomes is a shift in emphasis from a more narrow perspective of phone addiction and compulsive phone use to a broader perspective that does not a priori neglect the potential positive outcomes.

Given our results, we argue to consider a range of consequences of intense (or compulsive) phone use. Simply concentrating on stress or addictive symptoms does not account for the complexity of intercorrelated factors associated with the ownership and the use of one's smartphone. Just like relationships with humans can be both a resource to cope with stress as well as a source of stress, our phone use seems to be two-sided. To concentrate on one aspect only is therefore an incorrect simplification. In line with these ideas, we did not focus on preoccupation only, but also included trust in order to integrate somewhat antagonistic components of companionship. Confirming the multifactorial notion of smartphone use, trust in the smartphone showed comparatively low effects on stress but was more strongly related to coping. This is in line with theoretical

assumptions derived from human-human relationships. The concept of trust refers to the reliability and dependability of the relationship. The idea of a dependable and predictable companion to be less of a stressor and more of a resource for coping with stress seems to be true for both human as wells as smartphone companionships. Finally, effects of closeness on stress and coping were either fully mediated (in the case of stress) or partially mediated (in the case of coping) by trust and preoccupation. This suggests that closeness serves as a basis for the further development of both preoccupation and trust. Again, findings for digital companionship mirror the ambivalence that can be part of human-human companionship.

It is important to accept the limitations of any exclusive interpretations of multivariate associations. Circular and iterative causal processes are likely to play a role, too, and cannot be easily captured by a cross-sectional model. Longitudinal studies on human-human relationships have found evidence for a mutual cyclical growth of those factors that make for significant social ties (Wieselquist, Rusbult, Foster, & Agnew, 1999). It should also be noted that age, gender and overall phone usage were controlled for in the modelling. In light of the diversity of the sample, this allowed for a discussion of associations among variables without having to consider these background characteristics of sub-groups. At the same time, specific sub-groups of smartphone users obviously merit further investigation. In particular, we found that user characteristics were more strongly related to the constituents of companionship, rather than the outcomes of stress and coping. Some of these associations were less surprising: Older users reported lower levels of trust and preoccupation; more frequent users reported higher levels of closeness, trust and preoccupation. For gender, however, effects were less straightforward: Females reported lower levels of trust, but higher levels of preoccupation compared to males. Tempting as it is to relate these findings to gender differences found for human-human relationships, an exhaustive treatment of these issues was beyond the scope of the present work. At the very least, our findings call for a more fine-grained analysis of the different sub-groups of users. Furthermore, a longitudinal sampling of these more specific user groups would allow for an investigation of the development of companionship over time.

Other avenues for research can be identified from an in-depth consideration of the theoretical framework. Firstly, events which are known to be critical in human socializing, such as separation, loss, reinstatement, might possibly be transferred to digital companionship by assessing the psychological outcomes of, for example, separation from the smartphone, adjustment to a new phone or a new software version. Secondly, it would be useful to put the concept of digital companions to further tests. Is closeness to the smartphone something exclusively associated with the device itself, or is closeness more strongly derived from those humans typically accessed via the device? One step towards answering these questions would be to analyze smartphone usage more in depth, for example, regarding the intensity of usage of specific functions or regarding the relationship to these others the smartphone is used to communicate with.

# 5. Conclusions

The concept of digital companionship provides an alternative account of the extensive usage of our smartphones and the range of resulting behaviors: not in terms of addictive and pathological behavior, but as a multifaceted, meaningful relationship. Hence, we agree with the idea of devices to be extensions of ourselves or our cognitive capacity (Barnier, 2010; Clark, 2008). The phone does offer multiple possible uses that facilitate everyday life challenges regarding information, organization, navigation or communication. However, our conceptualization widens the perspective and goes beyond this technical or functional understanding of the device and emphasizes its capability to gratify basic human needs. Mobile communication can be considered as an extension of human communicative competencies as it resolves the constraints of time and collocation. Thus, mobile communication enables constant contact with family and friends, thereby increasing social connectedness and contributing to the gratification of fundamental human needs to belong (Ryan & Deci, 2000; Wei & Lo, 2006). Consequently, our phone is not only a technological device but a psychologically relevant entity. Earlier ideas of 'computers as social agents' seem to be predisposed to be transferred to modern smartphones. Desktop computers as rather bulky equipment have been shown to elicit social responses in their users (Reeves & Nass, 1996). We argue that the smartphone has become a highly suitable successor. Portable and constantly in touch with their users, addressing human senses and human needs more comprehensively and allowing for multi-faceted ways of interacting, smartphones seem to fulfil the requirements of a social actor to an even higher degree. Conceptualizing this fit in terms of a companionship offers starting points for future research as well as a more constructive perspective on individuals and their phones than simply pathologizing usage and neglecting psychological benefits.

## Declaration of Conflicting Interest

The Authors declare that there is no conflict of interest.

## Funding

This research was supported in part by a grant from Kaspersky Lab.

## Notes

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

[2] The t-test for partially overlapping samples utilizes the correlation between paired observations that occur in both samples to modify the variance term when estimating the test statistic. The test constitutes a generalized form of the known two-sample t-tests. In the absence of any unpaired observations, the test is fully equivalent to the paired-samples t-test. In the absence of any paired observations, it is fully equivalent to the independent-samples t-test (equal variances assumed) or the Welch test (unequal variances assumed). Technical details are easily accessible through Derrick, Toher, and White (2017).

[3] Note that standard errors, and p-values, are not available for indirect and total effects when using FIML in AMOS.

# References

Acevedo, B. P., & Aron, A. (2009). Does a long-term relationship kill romantic love? Review of General Psychology, 13(1), 59-65. doi:10.1037/a0014226

Barnier, A. J. (2010). Memories, memory studies and my iPhone: Editorial. Memory Studies, 3(4), 293-297. doi: 10.1177/1750698010376027

Barry, C. T., Reiter, S. R., Anderson, A. C., Schoessler, M. L., & Sidoti, C. L. (2017). "Let me take another selfie": Further examination of the relation between narcissism, self-perception, and Instagram posts. Psychology of Popular Media Culture, 6(1), 48-60. doi:10.1037/ppm0000155

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. Psychological Bulletin, 117(3), 497-529. doi:10.1037//0033-2909.117.3.497

Beyens, I., Frison, E., & Eggermont, S. (2016). "I don't want to miss a thing": Adolescents' fear of missing out and its relationship to adolescents' social needs, Facebook use, and Facebook related stress. Computers in Human Behavior, 64, 1-8. doi:10.1016/j.chb.2016.05.083

Binder, J. F., Roberts, S. G., & Sutcliffe, A. G. (2012). Closeness, loneliness, support: Core ties and significant ties in personal communities. Social Networks, 34(2), 206-214. doi:10.1016/j.socnet.2011.12.001

Bolger, N., DeLongis, A., Kessler, R. C., Schilling, E. A. (1989). Effects of daily stress on negative mood. *Journal of Personality and Social Psychology*, 57(5), 808-818.

Blackwell, D., Leaman, C., Tramposch, R., Osborne, C., & Liss, M. (2017). Extraversion, neuroticism, attachment style and fear of missing out as predictors of social media use and addiction. Personality and Individual Differences, 116, 69-72. doi:10.1016/j.paid.2017.04.039

Bowlby, J. (1988). A Secure Base: Parent-Child Attachment and Healthy Human Development. New York: Basic Books.

Brown, R. I. F. (1997). A theoretical model of the behavioural addictions – Applied to offending. In J. E. Hodge, M. McMurran, & C. R. Hollin (Eds.), Addicted to crime. Chichester, UK: John Wiley.

Buglass, S. L., Binder, J. F., Betts, L. R., & Underwood, J. D. (2017). Motivators of online vulnerability: The impact of social network site use and FOMO. Computers in Human Behavior, 66, 248-255. doi:10.1016/j.chb.2016.09.055

Buss, D. M. (2015). Evolutionary Psychology: The new science of the mind. Abingdon, New York: Routledge.

Carolus, A., Schmidt, C., Muench, R., Mayer, L., & Schneider, F. (2018). Pink stinks - at least for men. How minimal gender cues affect the evaluation of smartphones. In M. Kurosu (Eds.), Human-Computer Interaction. Interaction in Context. HCI 2018. Lecture Notes in Computer Science, vol 10902 (pp.512-525). Springer, Cham. doi:10.1007/978-3-319-91244-8_40

Carolus, A., Schmidt, C., Schneider, F., Mayr, J., & Münch, R. (2018). Are people polite to smartphones? How evaluations of smartphones depend on who is asking. In M. Kurosu (Eds.), Human-Computer Interaction. Interaction in Context. HCI 2018. Lecture Notes in Computer Science, vol 10902 (pp.500-511). Springer, Cham. doi:10.1007/978-3-319-91244-8_39

Christensen, A., & Heavey, C. L. (1990). Gender and social structure in the demand/withdraw pattern of marital conflict. Journal of personality and social psychology, 59(1), 73.)

Clark, A. (2008). Supersizing the mind: Embodiment, action, and cognitive extension. Oxford: Oxford University Press. USA.

Cunningham, S.J., & Macrae, C.N. (2011). The color of gender stereotyping. British Journal of Psychology, 102, 598-614.

Davies, R. (2017, May 31). Is our smartphone addiction damaging our children? Retrieved from https://www.theguardian.com/commentisfree/2017/may/31/smartphone-addiction-children-research-technoference-child-behaviour

Derrick, B., Russ, B., Toher, D., & White, P. (2017). Test Statistics for the Comparison of Means for Two Samples That Include Both Paired and Independent Observations. Journal of Modern Applied Statistical Methods, 16(1), 137-157. doi: 10.22237/jmasm/1493597280

Derrick, B., Toher, D., & White, P. (2017). How to compare the means of two samples that include paired observations and independent observations: A companion to Derrick, Russ, Toher and White (2017). The Quantitative Methods for Psychology, 13(2), 120-126. doi: 10.20982/tqmp.13.2.p120

Driscoll, R., Davis, K.E., & Lipetz, M.E. (1972) Parental Interference and Romantic Love: The Romeo and Juliet Effect. Journal of Personality and Social Psychology, 24, 1-10. http://dx.doi.org/10.1037/h0033373

Dunbar, R. I. (1998). The social brain hypothesis. Evolutionary Anthropology: Issues, News, and Reviews, 6(5), 178-190. doi:10.1002/(SICI)1520-6505(1998)6:5<178::AID-EVAN5>3.0.CO;2-8

Fullwood, C., Quinn, S., Kaye, L.K., & Redding, C. (2017). My virtual friend: A qualitative analysis of the attitudes and experiences of Smartphone users: Implications for Smartphone attachment. Computers in Human Behavior, 75, 347-355. doi: 10.1016/j.chb.2017.05.029.

Gehring, T. M., Funk, U. & Schneider, M. (1989). Der Familiensystem-Test (FAST): Eine drei-dimensionale Methode zur Analyse sozialer Beziehungsstrukturen. Praxis der Kinderpsychologie und Kinderpsychiatrie, 38 (5), 152-164.

Holmes, J.G. & Rempel, J.K. (1989). Trust in close relationships. In C. Hendrick (Ed.), Close relationships: Review of personality and social psychology, 10, 187-220.

Hookham, M., Togoh, I. & Yeates, A. (2016, February 21). Walkers Hit by Curse of the Smombie. Retrieved from https://www.thetimes.co.uk/article/walkers-hit-by-curse-of-the-smombie-kjpxbhm6cb0

Kelley, H. H., Berscheid, E., Christensen, A., Harvey, J. H., Huston, T. L., Levinger, G., McClintock, E., Peplau, L. A., & Peterson, D. R. (2002). Close Relationships. New York: Eliot Werner Publications.

Kenny, D. (2014). Structural equation modelling. Retrieved from http://www.davidakenny.net/cm/causalm.htm Accessed on 20/02/2016.

Knapton, S. (2016). Do you have 'ringxiety'? Anxious loners hear phantom phone calls. The Telegraph. Retrieved from http://www.telegraph.co.uk/news/science/science-news/12141126/Do-you-have-ringxiety-Anxious-loners-hear-phantom-phone-calls.html.

Kuss, D. J., & Lopez-Fernandez, O. (2016). Internet addiction and problematic Internet use: A systematic review of clinical research. World journal of psychiatry, 6(1), 143. doi:10.5498/wjp.v6.i1.143

Lee, E. J., Nass, C., & Brave, S. (2000). Can computer-generated speech have gender?: an experimental test of gender stereotype. CHI'00 extended abstracts on Human factors in computing systems, 289-290. doi:10.1145/633292.633461

Nass, C., Steuer, J., & Tauber, E. R. (1994). Computers are social actors. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems Celebrating Interdependence - CHI 94, 72.78. doi:10.1145/191666.191703

Newzoo International B.V. (2018). Top 50 Countries/Markets by Smartphone Users and Penetration. Retrieved from: https://newzoo.com/insights/rankings/top-50-countries-by-smartphone-penetration-and-users/

Nunnally, J. C. (1967). Psychometric theory. New York: McGraw-Hill.

Office of Communications (2018). Retrieved from: https://www.ofcom.org.uk/__data/assets/pdf_file/0022/117256/CMR-2018-narrative-report.pdf

Okazaki, S., Li, H., & Hirose, M. (2009). Consumer privacy concerns and preference for degree of regulatory control. Journal of Advertising, 38(4), 63-77. doi:10.2753/JOA0091-3367380405

Olmstead, K. (2017, May 25). A third of Americans live in a household with three or more smartphones. Retrieved from http://www.pewresearch.org/fact-tank/2017/05/25/a-third-of-americans-live-in-a-household-with-three-or-more-smartphones/

Perlman, D. & Fehr, B. (1987). The development of intimate relationships. In D. Perlman & S. Duck (Eds), Intimate Relationships. Developments, Dynamics and Deterioration (). Newbury Park, Beverly Hills, London, New Delhi: Sage.

Reeves, B., & Nass, C. I. (1996). The media equation: How people treat computers, television, and new media like real people and places. New York: Cambridge University Press.

Rempel, J.K., Holmes, J.G. & Zanna, M.P. (1985). Trust in close relationships. Journal of Personality and Social Psychology, 49, 95-112. doi: 10.1037/0022-3514.49.1.95

Rini, C., Schetter, C. D., Hobel, C. J., Glynn, L. M., & Sandman, C. A. (2006). Effective social support: Antecedents and consequences of partner support during pregnancy. Personal Relationships, 13(2), 207-229. doi: 10.1111/j.1475-6811.2006.00114.x

Roberts, J. A., & David, M. E. (2016). My life has become a major distraction from my cell phone: Partner phubbing and relationship satisfaction among romantic partners. Computers in Human Behavior, 54, 134-141. doi: 10.1016/j.chb.2015.07.058

Robles, T. F., & Kiecolt-Glaser, J. K. (2003). The physiology of marriage: Pathways to health. Physiology & behavior, 79(3), 409-416. doi: 1016/S0031-9384(03)00160-4

Ryan, T., Chester, A., Reece, J., & Xenos, S. (2014). The uses and abuses of Facebook: A review of Facebook addiction. Journal of Behavioral Addictions, 3(3), 133-148. doi:10.1556/JBA.3.2014.016

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. American Psychologist, 55, 68-78. doi: 10.1037/0003-066X.55.1.68

Samaha, M., & Hawi, N. S. (2016). Relationships among smartphone addiction, stress, academic performance, and satisfaction with life. Computers in Human Behavior, 57, 321-325. doi:10.1016/j.chb.2015.12.045

Satow, L. (2012). Stress- und Coping- Inventar (SCI) [PSYNDEX Tests-Nr. 9006508]. In Leibniz-Zentrum für Psychologische Information und Dokumentation (ZPID) (Hrsg.), Elektronisches Testarchiv. Trier: ZPID.

Sinclair, V. G., & Dowdy, S. W. (2005). Development and Validation of the Emotional Intimacy Scale. Journal of Nursing Measurement, 13(3), 193-206.

Tanis, M., Beukeboom, C. J., Hartmann, T., & Vermeulen, I. E. (2015). Phantom phone signals: An investigation into the prevalence and predictors of imagined cell phone signals. Computers in Human Behavior, 51, 356-362. doi:10.1016/j.chb.2015.04.039

Van der Meulen, R., & Pettey, C. (2017, November 30). Gartner Says Top Five Smartphone Vendors Achieved Growth in the Third Quarter of 2017. Retrieved from https://www.gartner.com/newsroom/id/3833964

Vorderer, P., Hefner, D., Reinecke, L., & Klimmt, C. (2018). Permanently Online, Permanently Connected: Living and Communicating in a POPC World. Routledge.

Walen, H. R., & Lachman, M. E. (2000). Social support and strain from partner, family, and friends: Costs and benefits for men and women in adulthood. Journal of Social and Personal Relationships, 17(1), 5-30. doi: 10.1177/0265407500171001

Walsh, S. P., White, K. M., Cox, S., & Young, R. M. (2011). Keeping in constant touch: The predictors of young Australians' mobile phone involvement. Computers in Human Behavior, 27(1), 333-342. doi: 10.1016/j.chb.2010.08.011

Wei, R. & Lo, V. H. (2006). Staying connected while on the move: Cell phone use and social connectedness. New Media & Society, 8(1), 53-72. doi: 10.1177/1461444806059870

Wieselquist, J., Rusbult, C. E., Foster, C. A., & Agnew, C. R. (1999). Commitment, pro-relationship behavior, and trust in close relationships. Journal of Personality and Social Psychology, 77(5), 942-966. doi: http://dx.doi.org/10.1037/0022-3514.77.5.942

Young, K. (2015). The evolution of Internet addiction disorder. In Internet addiction (pp. 3-17). Springer, Cham. doi:10.1007/978-3-319-07242-5_1