A Needs-Affordances-Satisfaction Perspective on the Use of Connected Objects

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Abstract

Individuals living a digital life find being connected via digital technologies is increasingly important to their overall well-being, especially as more and more everyday life objects provide connectivity features. However, we know little about the individual drivers and outcomes of using connected objects and the role of connectedness in this regard. This paper develops a needs-affordances-satisfaction perspective that posits that psychological needs motivate individuals' use of connected objects to the extent these objects provide affordances that satisfy such needs. We identify four connectedness affordances and formulate hypotheses that map the affordances to related psychological needs. We empirically test our predictions through a survey about the use of smartphones and connected cars. Our results have implications for research regarding connectedness and digital lives as well as for technology acceptance research and can enrich existing models by opening up the mechanisms through which psychological needs influence individual use of connected objects.

Keywords*:* Digital connectedness, digital life, connected objects, affordances, connectedness, technology acceptance

Introduction

Digital technologies nowadays permeate nearly every aspect of individual activity (Turel et al. 2020). With this development, people are progressively embracing a digital life - "a private life that is strongly affected by the use of digital technologies" (Hess et al. 2014, p. 247). A fundamental theme of digital life is that of connectedness (Shank et al. 2021). While a plethora of connected objects exist that provide the potential "to fulfill different social needs in users' daily life" (Touzani et al. 2018, p. 473), it is unclear how the use of connected objects is actually shaped by individual needs and how, in turn, the use of connected objects contributes to the satisfaction of these needs. In this regard, knowledge from the discipline of psychology is particularly valuable (Hess et al. 2014). Needs-based theories seem particularly suitable as psychological needs define the requirements for individual well-being (Brenner et al. 2014). As described by Karahanna et al. (2018, p. 738), “a needs-based theory is a powerful lens to explain why people use technology, particularly in contexts where use is personal and voluntary, without mandates and work performance goals”. As individuals are increasingly integrating digital technologies into their lives and managing almost all areas of life digitally, they are directly responsible for the consequences of their adoption and use decisions (Turel et al. 2020). Particularly, connected objects represent instances of current personal, voluntary, and ubiquitous use of technology (Touzani et al. 2017; Yoo 2010) that permeate nearly every aspect of individual activity (Carter and Grover 2015), thus rendering it promising to integrate motivational angles and theories in the examination of user behavior related to connected objects, thereby providing new perspectives and insights into user-centric research on technology acceptance.

Prior research has investigated technology acceptance and use for particular connected objects in various contexts (e.g., Berger et al. 2019, Warkentin et al. 2017) and has examined how specific technology attributes of connected objects influence customer satisfaction (e.g., Lee and Shin 2018). Research has recommended focusing on affordances, i.e., potential uses emerging from material properties (Seidel et al. 2013), instead of the particular technology per se (e.g., Tim et al. 2018). Research has described affordances in other IS contexts such as social media (e.g., Vaast et al. 2017) and delineated connectedness as a broad affordances category for personal IT artifacts (Cousins and Robey 2015; Scheepers and Middleton 2013). However, to the best of our knowledge, no prior study has systematically derived and differentiated connectedness affordances that cater to digital lives and investigated their relation to psychological needs. Also lacking are attempts to theorize and empirically confirm a relationship between psychological needs and connectedness affordances as an explanation for the use of connected objects. However, both aspects seem particularly relevant.

First, technology uses are deeply embedded in personal lives. Accordingly, motivations and consequences of use are related to very personal aspects that go beyond established technology acceptance models (Jung 2014). In other words, “As use of information technology has become ubiquitous, personal, and voluntary, our theorizing of why people use technology has to embrace other theoretical perspectives of what motivates human action” (Karahanna et al. 2018, p. 752). Given that psychological needs are universal, our theorizing can be incorporated into situation-specific models of user behaviors in a connected object context (Karahanna et al. 2018). Second, given the diversity and distribution of connected objects, a focus on affordances instead of the specific technology allows for more systematic and generalizable theorizing (Scheepers and Middleton 2013). Third, while the importance and value of connectedness affordances has been recognized (e.g., Cousins and Robey 2015), currently no systematically derived and differentiated set of connectedness affordances exists. Thus, our work can help to build a platform for research on connected objects by providing a conceptual foundation and common vocabulary for future work.

Therefore, our study addresses the following research questions:

1. What are the salient affordances that connectivity features of connected objects provide?
2. How is the use of connected objects driven by specific psychological needs?
3. How do these connectedness affordances contribute to fulfilling specific psychological needs?

To answer these questions, we derive a theoretical framework comprising four particular connectedness affordances and their linkages to individual needs. Drawing on the results of a survey (n=405) about the use of two connected objects—smartphones and connected cars—we find that the innate psychological needs for relatedness, competence, and autonomy are significantly associated with these connectedness affordances. Further, through additional analysis, we find that the use of features that provide connectedness affordances have a significant positive impact on overall satisfaction with the connected object as a whole.

Our work contributes to research with an overarching comprehensive framework for connectedness affordances and the psychological needs that motivate their use. Further, our study contributes by revealing the interplay of connectedness affordances (regardless of the particular technology) and personal, innate needs. Finally, we provide implications for technology acceptance research by opening up the mechanisms through which psychological needs influence user perceptions of connected objects and their use patterns and behaviors.

Conceptual Framework

We assume that connected objects such as smartphones and connected cars exhibit connectedness affordances whose usage are motivated by certain psychological needs and that can in turn fulfill these needs. However, the concepts of psychological needs and the satisfaction of these needs cannot simply be equated. For example, while the need for relatedness (this concept will be defined in the section Theory and Hypotheses) may motivate the use of certain connectedness affordances, it is not certain that this also leads to an actual satisfaction of the need. Hence, in order to fully understand the influence of universal psychological needs on the usage of connected objects and connectedness affordances as well as the degree to which this usage can lead to the actual satisfaction of psychological needs, it is crucial to separate these two concepts. Furthermore, following prior work, we see affordances as potential uses originating in material properties (Seidel et al. 2013), in our case connectivity features. This perspective on the action potentials of technology is "particularly suited to examining previously unrecognized roles of emerging technology" (Tim et al. 2018, p. 49), connected objects in our case, and, therefore, allows new theoretical insights (Markus and Silver 2008). In the following section, we explain the essential conceptual building blocks of this line of reasoning. Figure 1 depicts the logic of our needs-affordances-satisfactions framework.

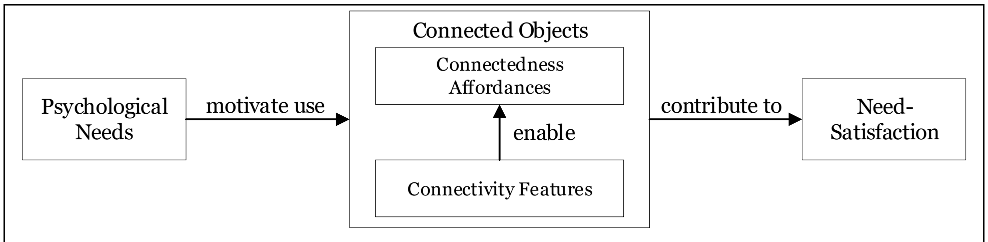


Figure 1. Needs-Affordances-Satisfaction Framework

Connectivity Features and Connected Objects

Connectivity refers to the ability of single objects to build networks and connect to information infrastructures through communication technology (e.g., Berger et al. 2016). Connectivity features go beyond this technological attribute of objects (Byrd and Turner 2000) in that they do not merely describe network technology components but are also related to the functionality provided to users.

Connectivity features are essential elements of connected objects, which also comprise other features: (1) physical features describing hardware components (Yoo et al. 2010) and (2) computing features that render objects smart (Porter and Heppelman 2014). Connectivity features then build on outbound linkages to support user tasks: "Smart components amplify the capabilities and value of the physical components, while connectivity amplifies the capabilities and value of the smart components and enables some of them to exist outside the physical product itself" (Porter and Heppelman 2014, p. 5). From a general perspective, connected objects provide utilitarian, hedonic, and social value to their users (Touzani et al. 2018).

Connectedness and Connectedness Affordances

We observe a state of confusion in the IS and management domain concerning the conceptualization of connectedness. It is often either understood as being linked to other social actors (e.g., Atuahene-Grima 2003) or conceptualized as a feeling of belongingness (e.g., Naseri and Elliott 2011). Furthermore, these different conceptualizations are sometimes intermingled and not clearly delineated from each other (e.g., Riedl et al. 2013). To achieve more clarity in the scholarly discourse, we argue that it is necessary to separate a state of connectedness from its affective outcomes.

A definition that is helpful in this regard was provided by Touzani et al. (2018, p. 473): "Connectedness refers to the degree to which a connected object helps users stay connected with others and create/keep social relationships". In the digital age, however, connectedness goes beyond this understanding. Using connected objects in everyday life settings resembles the idea of experiential computing, described as "digitally mediated embodied experiences in everyday activities through everyday artifacts that have embedded computing capabilities" (Yoo 2010, p. 213). These individual experiences in turn are described by four dimensions that are mediated by technology: actors, time, space, and artifacts. While prior research on connectedness has focused on the actor dimension, technical advances have led to the remaining three dimensions being increasingly digitally mediated for individuals living a digital life (Turel et al. 2020). Furthermore, the artifact dimension can be split up into digital products/services on the one side and technologies on the other, while time and space dimensions can be merged into spatio-temporal contexts (Yoo 2010). An example for the latter would be a connected object providing real-time information on traffic on the planned route ahead.

Accordingly, we define digital connectedness as the degree to which a connected object helps users stay connected with other actors, as well as artifacts (i.e., digital products/services as well as technologies) and spatio-temporal contexts (i.e., time and space dimensions). Digital connectedness then translates into specific connectedness affordances, which are, in turn, enabled by connectivity features. Conceptually, connectedness affordances sit between the aforementioned definition of digital connectedness as well as its grounding in theoretical frameworks (Scheepers and Middleton 2013) and the connectivity features of connected objects. Building on this two-pronged approach, we derive four connectedness affordances: connectedness to digital products/services, connectedness to social relationships, connectedness to technologies, and connectedness to spatio-temporal contexts. Table 1 defines and describes these affordances and provides illustrative examples.

Affordance	Description & Example Features
Connectedness to digital products/ services: enables users to connect to digital products and services that they regularly use.	Users can access and interact with digital products and services that they use on a regular basis (e.g., listening to music from Spotify in a connected car, conducting online banking transactions on a smartphone). Digital products and services describe products or services that are either embodied in information and communication technologies or enabled by them (Lyytinen et al. 2016).
Connectedness to social relationships: enables users to connect to other social actors.	Users can access and interact with other persons to keep or create social relationships through the connected object. These objects enable them to communicate information to others and provide access to others in the individual's social world (Carter and Grover 2015), for example by chatting with a friend via WhatsApp on the smartphone or sharing fitness activities with others via a smartwatch.
Connectedness to technologies: enables users to connect to other devices.	Users can access and interact with other devices to control and/or monitor them. This allows objects to work together as assemblages and expands the range of what the user can do with them (Hoffman and Novak 2018), for instance turning on the coffee maker via a tablet, or locking and unlocking a car with the smartphone.
Connectedness to spatio-temporal contexts: enables users to connect with physical environments, defined by time and space.	Users can monitor states and changes of states of real-world environments such as temperature or traffic through the connected object. Thus, they are provided with information about contextual conditions relevant to them, which can be near and far (Yoo 2010) such as real-time traffic information via Google Maps on a smart watch or supporting sports activities through the Runtastic app.

Table 1. Affordances Types and Examples

Theory and Hypotheses

We draw on a needs-based perspective. At the beginning of our work, we considered several theories from the field of technology acceptance such as the Technology Acceptance Model or the Theory of Planned Behavior. However, in contrast to such theories regarding technology use (e.g., Venkatesh et al. 2012), primarily focusing on situational motivations such as performing well at work, needs-based theories transcend situations to address universal life needs (Karahanna et al. 2018). More precisely, we draw on self-determination theory (Deci and Ryan 1987) because the needs suggested by this theory are universal in nature and independent from one's learning experiences. Furthermore, self-determination theory seems well suited to the context of connected objects since the needs of autonomy, relatedness, and competence—the focus of the theory—appear closely related to the utilitarian, hedonic, and social value that connected objects can provide (Touzani et al. 2018). In the following, we theorize about the relationship of these needs to connectedness affordances.

Need for Autonomy

Autonomy is the innate psychological need "to be the causal agent of one's own life and act in harmony with one's integrated self" (Karahanna et al. 2018, p. 739). Thus, individuals preferably not engage in activities because they must, but because they want to (Deci 1995).

We argue that the need for autonomy will motivate the use of connectivity features that provide the affordance of connectedness to digital products/services regularly used. For example, using digital products and services such as online banking makes individuals more knowledgeable and enhances their choices, which users increasingly demand in the form of "instant access to personalized content on their own terms" (Berman and Kesterson-Townes 2011, p. 29).

Second, we posit that the use of connectivity features that enable the affordance of connectedness to social relationships is motivated by the need for autonomy, as it increases, for instance, users' flexibility by allowing them to stay in contact with colleagues and customers outside traditional work hours (Cousins and Robey 2015).

Finally, we assume that the need for autonomy motivates the use of connectivity features that provide the affordance of connectedness to technology by allowing individuals to control and operate assemblages of different technologies to support daily activities according to genuine preferences, for example in the context of smart home (Berger et al. 2016; Scheepers and Middleton 2013).

Thus, we hypothesize:

> **H1**: Individuals' need for autonomy will motivate use of connectivity features that provide these affordances: connectedness to regularly used digital products/services, connectedness to social relationships, and connectedness to technologies.

Need for Relatedness

The innate psychological need for relatedness encompasses the need to "feel understood, connected with, and appreciated by close others" (Sheldon and Niemiec 2006, p. 331). As connected objects bear the potential to connect directly with others (Touzani et al. 2018), we posit that an individuals' need for relatedness motivates the use of connectivity features that enable the affordances of connectedness to digital products/services and to social relationships for the following reasons:

Being connected to regularly used digital products/services and social relationships through connected objects allows users to (1) strengthen their social links through conversations, content sharing, or get in touch with a community by playing such as Pokémon Go, (2) share their own experiences and performance, and (3) establish new social relations with people who use similar connected objects (e.g., Lang et al. 2013; Touzani et al. 2018). Therefore, we hypothesize:

> **H2**: Individuals' need for relatedness will motivate use of connectivity features that provide these affordances: connectedness to regularly used products/services and connectedness to social relationships.

Need for Competence

Competence refers to the need "to feel effective, efficient, and masterful vis-à-vis the environment" (Sheldon and Niemiec 2006, p. 331). We argue that individuals with a high need for competence seek affordances that allow them to expand and demonstrate knowledge and capabilities in their environments (Karahanna et al. 2018).

First, we hypothesize that the need for competence will motivate the use of connectivity features that provide the affordance of connectedness to social relationships. For example, by applying and sharing their knowledge on a topic with a large community (Ransbotham et al. 2016), users of connected objects can share their opinions and capabilities with others and thus, experience a feeling of conformity (Touzani et al. 2018).

Second, we argue that the need for competence will motivate the use of connectivity features that have the affordance of connectedness to technology. For instance, connected objects provide their users the ability to monitor and control other technologies such as lights and coffeemakers that can be controlled in order to allow individuals to shape daily life in a pleasant and efficient manner (Berger et al. 2016).

Third, we posit that the need for competence will motivate the use of connectivity features that have the affordance of connectedness to spatio-temporal contexts. A connected car, for example, can provide drivers with real-time information about contextual conditions of their environments such as the current traffic situation in order to make better decisions (Mikusz and Herter 2016).

Overall, these aspects lead to the following hypothesis:

> **H3**: Individuals' need for competence will motivate use of connectivity features that provide these affordances: connectedness to social relationships, connectedness to technology, and connectedness to spatio-temporal contexts.

Need Satisfaction

Simply using a system is not sufficient to obtain the expected benefits; the use of a system must also be effective. In terms of the needs-affordances-satisfaction perspective, to be effective, the use of connected objects must also contribute to satisfying the corresponding needs. In the following, we outline our hypotheses with regard to need satisfaction through connectedness affordances.

The use of connectivity features that enable the affordances of connectedness to digital products/services, social relationships, and technology is expected to satisfy individuals' need for autonomy. For example, a smart lock that is connected to an individual's smartphone can send notifications in case the door is unlocked (Püschel et al. 2016), allowing the person to leave the house and participate in leisure activities without having to fear burglaries. Therefore:

> **H4**: The use of connectivity features that provide the following affordances will lead to a satisfaction of individuals' need for autonomy: connectedness to regularly used digital products/services, connectedness to social relationships, and connectedness to technology.

Second, we posit that the use of connectivity features that provide the affordances of connectedness to digital products/services and social relationships will satisfy the need for relatedness. For instance, by allowing users to meet and know new people who use similar objects, connected objects enable users to explore interests and activities of other members within a community (Touzani et al. 2018) and thereby satisfy an individual's need for relatedness. Hence, we propose:

> **H5**: The use of connectivity features that provide the following affordances will lead to a satisfaction of individuals' need for relatedness: connectedness to regularly used digital products/services and connectedness to social relationships.

Lastly, we argue that using connectivity features that enable the affordances of connectedness to social relationships, technology, and spatio-temporal contexts will satisfy an individual's need for competence. As exemplified by smart meters, linking these connected objects with other devices allows consumers to monitor and evaluate appliance use patterns to identify potential reductions in electricity consumptions (Warkentin et al. 2017). As a result, consumers can run the household more efficiently and effectively. Thus:

> **H6**: The use of connectivity features that provide the following affordances will lead to satisfaction of individuals' need for competence: connectedness to social relationships, connectedness to technology, and connectedness to spatio-temporal contexts.

While other relations between psychological needs and the use of certain connectivity features/connectedness affordances are plausible, we decided against hypothesizing them for theoretical considerations. For example, based on the definition of the need for autonomy (Karahanna et al. 2018), we argue that individuals that want to act autonomously do not primarily need or want information on their spatio-temporal contexts that could potentially influence or (from their perspective) manipulate their behavior. Thus, we did not hypothesize that the need for autonomy will motivate the use of connectivity features providing connectedness to spatio-temporal contexts. Similarly, in order to fulfill the need for relatedness and again based on its definition in the literature (e.g., Sheldon and Niemiec 2006), we posit that individuals need to be able to communicate with their social environment, either directly or via certain digital products and services. Hence, we did not hypothesize that the need for relatedness influences the use of connectivity features providing connectedness to technology or spatio-temporal contexts. Lastly, we see digital products and services predominantly as tools to consume content, for example music or videos, or to perform certain, clearly defined tasks like carrying out a bank transfer. Following this train of thought as well as the prevalent understanding regarding the need for competence as being expressed by expanding and demonstrating knowledge (e.g., Karahanna et al. 2018), we argue that performing such activities is not associated with the concept of competence by many individuals. Thus, we did not hypothesize that the need for competence will motivate the use of connectivity features providing the affordance of connectedness to digital products and services.

Methodology

Instrument Development

We developed two versions of our questionnaire. One version focused on the use of smartphone features, while the other focused on connected car feature use. Hence, the participants were presented different connectivity features that were selected based on a synthesis of relevant research as well as product offerings, depending on the context they were assigned to. Details of the features are listed in Table 1A in the Appendix. We chose these two types of connected objects for two reasons. First, as many individuals always carry their smartphones with them, it represents a connected object that can be used in almost all spheres of life (Hess et al. 2014). Second, individuals use connected car features primarily in the context of mobility, associating their use strongly with the task of driving. Thus, these two connected objects enable us to validate our theory in two different contexts. In both versions, we measured six established constructs using seven-point Likert scales: autonomy need, relatedness need, competence need, autonomy need satisfaction, relatedness need satisfaction, and competence need satisfaction. Details regarding all measures and their sources are listed in Table 1A in the Appendix.

We assigned the identified connectivity features to the four connectedness affordances following Karahanna et al. (2018). We then asked seven IS researchers to map these features to the four connectivity affordances of our conceptual framework to validate our allocation. In cases where not all researchers agreed, but at least 70% (5 out of 7 researchers) assigned a feature to a particular affordance, we discussed the differences and added examples to the feature description for clarification purposes. Features for which the allocation did not reach the 70%-level, were dropped.

The extent to which individuals use these features was measured on a five-point Likert scale (Karahanna et al. 2018). Before collecting the data, we performed a small-scale pretest with the seven IS scholars as well as 12 regular consumers, who were asked to review the survey and provide feedback concerning the instructions, items, and survey structure. They proposed only minor changes (e.g., correcting spelling mistakes) and confirmed that the instructions were clear and easy to follow.

Sampling Design

To collect data from a wide audience, we surveyed a sample of German consumers in cooperation with a market research company that rewarded the participants with points they can exchange for vouchers. Our target group comprised consumers that possess either a smartphone or a car with connected car features. To help participants better understand whether their car possessed connectivity features, we provided them with some examples. Participants who possessed neither a smartphone nor a car with connected car features were sorted out. Furthermore, as we were aiming for two evenly sized subsamples, we imposed quotas for each group.

In sum, 511 complete responses were collected. After screening out respondents who took unusually little time and/or gave implausible answers, we had a sample of 405 responses, of which 213 participants completed the survey concerning their smartphone use and 192 participants completed the survey concerning connected car use. Across both groups, most of the participants were in the age range 30-49 years, 37% of the participants were female and 60% were male (the rest preferred not to say), and the majority of the participants had either a university degree or a completed apprenticeship and were employees

Data Analysis and Results

Measurement Model Assessment

The research model was tested using the partial least squares (PLS) method of structural equation modeling (SEM) (SmartPLS v. 3, Ringle et al. 2015). PLS allows inclusion of single-measured constructs in research models (Petter 2018). This feature was important as we had two affordances for which only one connectivity feature could be identified.

Smartphone Case														
	Mean	**SD**	**CR**	**AVE**	**NFA**	**NFR**	**NFC**	**CPS**	**CSR**	**CT**	**CSC**	**SNA**	**SNR**	**SNC**
NFA	6.23[1]	.96	.895	.741	**.861**									
NFR	4.78	1.43	.892	.674	.064	**.821**								
NFC	5.27	1.27	.864	.680	.195	.481	**.825**							
CPS	2.49	1.36	.838	.565	-.145	.364	.313	**.751**						
CSR	3.11	1.35	.793	.563	.136	.492	.276	.556	**.751**					
CT	2.01	1.23	1	1	-.152	.296	.164	.304	.304	**1**				
CSC	2.96	1.23	.865	.517	.018	.441	.347	.719	.657	.608	**.739**			
SNA	4.84	1.56	.923	.800	.148	.487	.394	.415	.450	.273	.463	**.894**		
SNR	4.77	1.70	.932	.820	.154	.438	.337	.338	.519	.204	.387	.638	**.905**	
SNC	4.46	1.61	.845	.845	.054	.527	.424	.498	.474	.357	.474	.775	.646	**.919**
Connected Car Case														
	Mean	**SD**	**CR**	**AVE**	**NFA**	**NFR**	**NFC**	**CPS**	**CSR**	**CT**	**CSC**	**SNA**	**SNR**	**SNC**
NFA	6.12	1.06	.901	.752	**.867**									
NFR	4.82	1.42	.889	.667	.052	**.817**								
NFC	5.43	1.18	.805	.585	.327	.305	**.765**							
CPS	3.02	1.46	.855	.747	-.093	.451	.216	**.864**						
CSR	2.51	1.32	1	1	-.287	.460	.166	.524	**1**					
CT	2.81	1.27	.891	.803	-.192	.330	.222	.480	.537	**.896**				
CSC	3.4	1.21	.851	.590	.017	.386	.283	.600	.522	.545	**.768**			
SNA	4.81	1.63	.917	.787	.045	.440	.213	.440	.420	.473	.556	**.887**		
SNR	4.45	1.84	.949	.862	-.038	.470	.252	.491	.528	.487	.567	.787	**.928**	
SNC	4.49	1.66	.942	.844	.004	.471	.259	.414	.497	.517	.561	.791	.793	**.919**
Note: NFA = need for autonomy; NFR = need for relatedness; NFC = need for competence; CPS = connectedness to digital products/services; CSR = connectedness to social relationships; CT = connectedness to technology; CSC = connectedness to spatio-temporal contexts; SNA = satisfaction of need for autonomy; SNR = satisfaction of need for relatedness; SNC = satisfaction of need for competence; SD = standard derivation; CR = composite reliability; AVE = average variance extracted														

Table 2. Construct Reliability and Validity and Discriminant Validity

[1] We acknowledge that the mean values for the need for autonomy are quite high in both cases. However, similar studies obtained comparably high values (e.g., Karahanna et al. 2018).

Table 2 presents information about construct reliability and validity. In both cases, the composite reliability values of all constructs were above the recommended cut-off value of .70, indicating adequate internal consistency (e.g., Beaudry and Pinsonneault 2010). Convergent validity is demonstrated as the AVE values for all constructs were higher than the suggested threshold value of .50 (Fornell and Larcker 1981), both for the smartphone and the connected car case. Comparing the square root of the AVE with the correlations among the constructs indicates that each construct is more closely related to its own measures than to those of other constructs, thus supporting discriminant validity (Chin 1998).

Next, we inspected the item loadings. Items that loaded weakly on constructs were eliminated from further analyses. The majority of the items loaded strongly on the intended constructs, with item-to-construct loadings between .631 and 1 (connectedness to social relationships was measured by one item) in the connected car case and only three loadings lower than .70 and item-to-construct loadings between .667 and 1 (connectedness to technology was measured by one item) in the smartphone case and only two loadings lower than .70. While items-to-constructs loadings are typically above .70 in exploratory studies, loadings of .40 are acceptable (Hulland 1999). Thus, our results supported convergent validity.

Finally, we assessed the extent of common method bias with Harman's one-factor test (Podsakoff and Organ 1986). Evidence for common method bias would appear when one of the constructs accounts for the majority of the covariance among all constructs. In both samples, however, no construct accounted for more than 50% of the covariance among all constructs. Thus, common method bias did not seem to have affected the results.

Structural Model Assessment and Hypothesis Testing

Figure 2 presents the PLS results, which show the standardized path coefficients among the constructs using the bootstrap resampling method. In the following, we describe the results for each case.

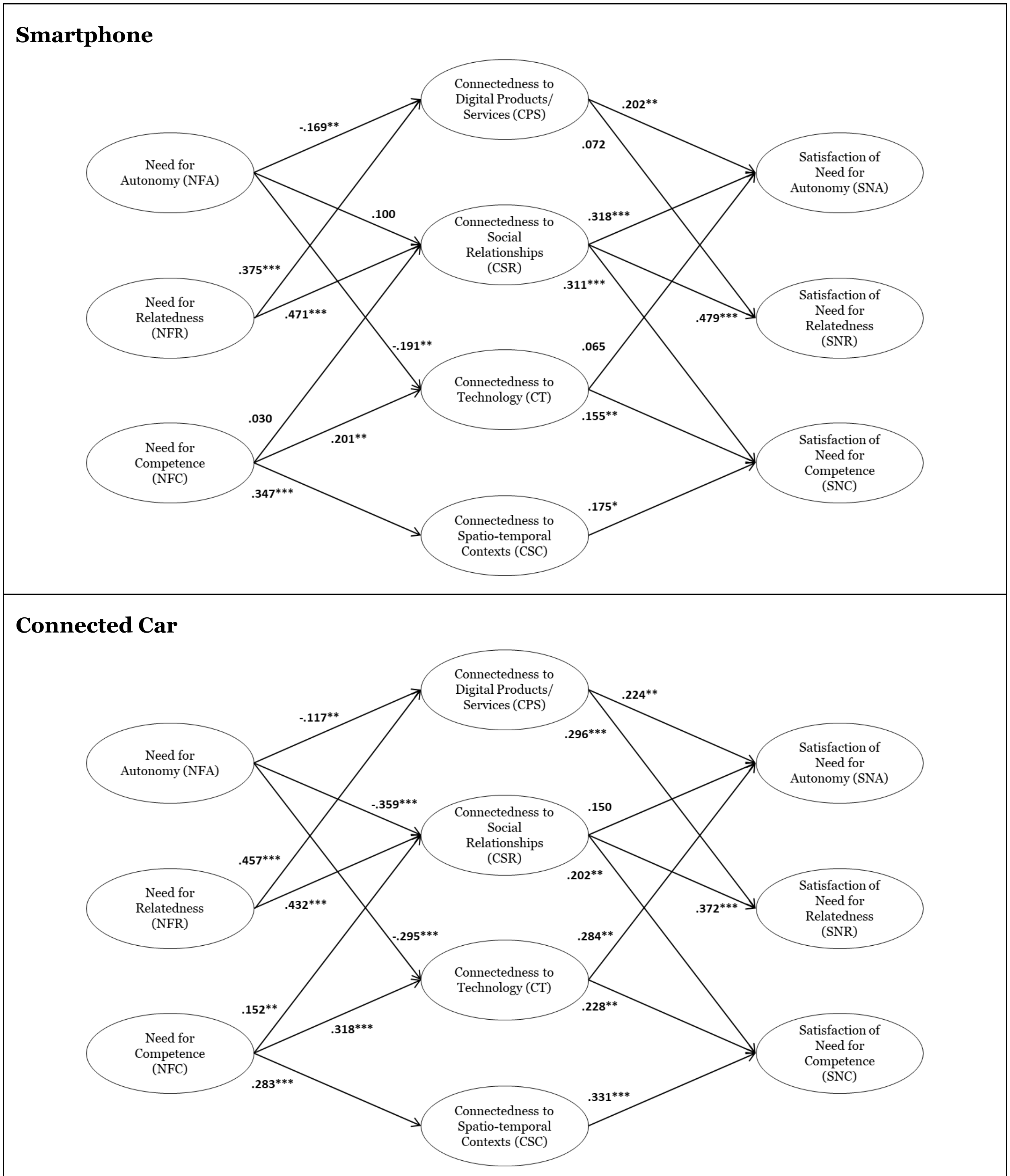
For smartphones, H2 and H6 were supported, since all paths were as hypothesized positive and significant. H3 to H5 were only partially supported. While all relations were found to be positive, the paths from need for competence to connectedness to social relationships, connectedness to digital products/services to relatedness need satisfaction, and connectedness to technology to autonomy need satisfaction were insignificant. Contrary to our expectations, need for autonomy is negatively related to connectedness to digital products/services and to technology. The path from autonomy need to connectedness to social relationships was positive, however, it was insignificant. Thus, H1 was not supported.

Overall, the constructs of connectedness to digital products/services, to social relationships, to technology, and to spatio-temporal contexts explained 29.6% of the variance of autonomy need satisfaction, 34.2% of the variance of relatedness need satisfaction, and 40.4% of the variance of competence need satisfaction in the smartphone case.

For connected cars, all paths as proposed in H2 to H6 were found to be positive and significant (except for the path from connectedness to social relationships to autonomy need satisfaction). Thus, H2, H3, H5, and H6 were fully supported, with H4 only partially supported. Similar to the smartphone case and against our expectations, need for autonomy is negatively related to connectedness to social relationships, to digital products/services, and to technology. Thus, H1 was again not supported.

Concerning the explanation of variance of the need satisfaction in the connected car case, connectedness to digital products/services, to social relationships, to technology, and to spatio-temporal contexts explained 17% of the variance of autonomy need satisfaction, 19.2% of the variance of relatedness need satisfaction, and 20.1% of the variance of competence need satisfaction.

We conducted an additional analysis to examine the influence of connectivity feature use on the overall satisfaction with a connected object. We therefore measured the use of the connected object as an aggregate of feature use (Karahanna et al. 2018). The overall satisfaction with the connected object was measured with the items as proposed by McKinney et al. (2002). The items are listed in Table 1A in the Appendix. In both cases, the aggregated use of connectivity features had a positive and significant influence on the overall satisfaction with the product, with path coefficients of .357 ($t = 5.713$, $p < .001$) in the connected car case and .176 ($t = 3.017$, $p < .05$) in the smartphone case, thus indicating the importance of connectivity feature use and the connectedness affordance they have on the overall satisfaction with the connected object.



Note: *p < .1; ** p < .05; *** p < .001

Figure 2. Structural Model Results

Discussion of Findings

Contrary to our expectations, we found negative associations between the need for autonomy and the respective affordances in both samples. This finding contrasts with prior findings of a positive and significant influence of the need for autonomy on browsing others' content, which can be at least partially related to affordances of connectedness to social relationships (Karahanna et al. 2018). Although these affordances may help individuals to live in an autonomous manner, our results suggest that the need for autonomy is not why smartphone or connected car users select these products. One possible explanation could be that individuals who particularly emphasize being the causal agents of their own life do not want to be dependent on connected objects and their affordances, but instead take matters into their own hands.

Regarding our second hypothesis, the examined associations were positive and significant in both cases. Thus, our results support prior research stating that individuals seek to satisfy their needs to keep up seamless, constant, and synchronized connections with their social relationships by using connectivity features of connected objects that foster communication with friends or family via messengers or social networks (Touzani et al. 2018).

For the third hypothesis, we found positive links that were also significant. An exception was the associations between the need for competence and connectivity to social relationships in the smartphone case. We discuss this point later. Prior research has found that individuals look for utilitarian value, such as support for a productive daily life, in connected objects that help them carry out everyday tasks efficiently (Aldossari and Sidorova 2020, Touzani et al. 2018). Our findings support these assumptions.

We found significant positive links for H4 in both cases. The links between connectedness to technology and autonomy satisfaction for the smartphone and between connectedness to social relationships and autonomy satisfaction for the connected car were insignificant. For the smartphone case, one possible explanation could be that individuals view being connected to multiple technologies not as a form of autonomy, but more as a risk of becoming dependent on these devices. With regard to the connected car, drivers may feel that their autonomy is constrained by being reachable by others, for example from work (Mazmanian et al. 2013). However, although the need for autonomy does not seem to motivate the use of these affordances, our results suggest that they nevertheless have a positive impact on the satisfaction of this need. Thus, our findings support prior research on the influence of connectedness affordances on autonomy need satisfaction.

As to H5, the links were positive and significant. However, the link between connectedness to regularly used digital products/services and relatedness satisfaction in the smartphones case was insignificant. This finding may suggest that individuals use digital products/services for other reasons or that, if they can choose between different affordances to satisfy their need for relatedness, they choose features that enable direct communication with others (e.g., messengers). Still, our findings confirm prior observations that individuals can use connected objects to satisfy their need for relatedness (e.g., Touzani et al. 2018).

Finally, regarding H6, all links were positive and also significant. Our findings also confirmed prior research stating the potential of connected objects to enhance individuals' feelings of competence by enabling them to deal with their environments in an efficient way, especially in the context of smart home technology (e.g., Hoffman and Novak 2018).

A comparison of the results from the smartphone and connected car cases reveals similar relationships between psychological needs and the use of connectivity features and the influence of using the connectivity features on need satisfaction. In both cases, the need for autonomy had (against our expectations) a negative impact on the use of features that have the affordances of connectedness to social relationships, digital products/ services, and technology. As we have noted, this might be because individuals with a high need for autonomy want to take matters into their own hands and not have to rely on the connected object. For example, connected car users may not want to depend on receiving information such as the fuel or oil level on their smartphone, but would rather monitor and control the vehicle status themselves.

As expected, the remaining links were positive in both cases. However, some differences appeared concerning the significance of these relationships. A particularly interesting difference concerned the need for competence and the use of features that have the affordance of connectedness to social relationships. While an insignificant relationship existed in the smartphone case, use of features that have the affordances of connectedness to social relationships was significantly motivated by the need for competence in the connected car case. A possible explanation could be that as cars conventionally do not offer the ability to communicate with others, being able to reach friends or family while driving might be viewed as something unusual that requires a certain degree of competence. In the smartphone case, however, being able to communicate with others might be taken for granted and thus it is not associated with a need for high competence, nor with higher satisfaction.

Independently from the specific results, the differences between the smartphone and connected car case illustrate the importance as well as the value of examining different kinds of digital technologies (in our case two different kinds of connected objects) in different contexts in order to obtain more meaningful and in-depth insights. As an example, smartphones represent a technology that by default provides connectivity features, while this is still emerging for connected cars. This might also influence users' association of connectivity features with certain individuals needs and their satisfaction.

Implications

Implications for Research

Our results provide valuable contributions for inquiries about connectedness, digital life, and technology acceptance.

First, we contribute to work related to the notion of connectedness. While the growing importance of connectedness is widely acknowledged (e.g., Ransbotham et al. 2016), its interaction with consumer behavior has not been considered. The results of our additional analysis of the influence of the use of connectivity features on overall satisfaction with the respective product provide empirical evidence for the notion that connectedness is of increasing importance across contexts (Touzani et al. 2018). More importantly, our work casts connectedness in a new light. In providing a needs-affordances-satisfaction framework, we distinguish between connectedness (differentiated into four distinct affordances), its drivers, and its outcomes, allowing for a more fine-grained analysis of the relationships. Second, The four connectedness affordances that we derived from both conceptual thought and prior work about connected objects found empirical support in our study. We contend that, in the digital age, connectedness is not only about using IT to connect with other people but also about using other connected technologies, products, and services when interacting with the environment in everyday life. Our findings show that people are driven by innate needs to use and extend digital connectedness by using connectivity features.

Second, we contribute to research about digital life, as the needs-affordances-satisfaction framework helps to expand the understanding of human behavior in the era of digitalization (Carter and Grover 2015). Our framework responds to calls for harnessing knowledge from other disciplines such as psychology in order to approach the topic of digital life and digitalized individuals (Turel et al. 2020). Thereby, we refrain from solely explaining technology adoption but provide a perspective that focuses on the individual and the mechanisms by which he or she achieves satisfaction in everyday life. Furthermore, our findings indicate that people are driven to use connected objects by fundamental, innate needs, and use contributes to satisfying these needs and thus enhances overall well-being. Interestingly, our empirical results differed only slightly between smartphone and connected car users. We selected these two technologies because they are located at rather extreme points on a continuum of the aspects of life that can be covered by connected objects (Hess et al. 2014). The fact that our investigation revealed only marginal differences indicates the robustness of the connectedness affordances across technology artifacts and use contexts.

Third, we contribute to research about technology acceptance. In our work, we follow recommendations to 1) focus on technology use and also connect it with individual outcomes (Venkatesh et al. 2016), 2) examine technology feature use (Leonardi 2013), and 3) investigate the multiplicity of IT artifacts rather than adopting a singular view on them (Carroll 2008). Here, the needs-affordances-satisfaction framework provides two valuable insights. First, as the results of our study indicate that people are driven to use connected objects by psychological needs and respective use contributes to satisfying these needs, we can assume that a high overlap level between these needs and the connectedness affordance of a technology also influences a customer's choice of using certain technologies, hence providing new insights into and new perspectives on how and why people use connected objects. Second. prior work has revealed the so-called "autonomy paradox," which holds that people perceive higher levels of autonomy from using mobile technology but indeed become less autonomous (Mazmanian et al. 2013). Our study reveals the opposite:

people who want to be autonomous refrain from using connectivity features. At the same time, those who use these features perceive a higher level of autonomy. Possibly, a decade after Mazmanian et al. (2013) collected data, people have gathered experiences of the downsides of being connected (Tarafdar et al. 2013), such as threats to the work-life balance (Benlian 2020), and project this negativity onto connectivity features. However, with objects providing more and more connectedness to private relationships, data, and services and the positive effect their use has on individual satisfaction (Pathy and Sujatha 2022), skepticism might vanish over time.

Implications for Managerial Practice

Our study also has important implications for managerial practice. First, our results reveal that connectedness affordances are intertwined with individual satisfaction, rendering them relevant for product managers. For many firms, however, this perspective might entail a change in their reasoning. Instead of solely considering the potential direct effects of new digital technologies for the products or services in question, managerial attention must expand to encompass the existing landscape of digital services, devices, and networks deployed by individuals (Matt et al. 2019). In response, firms should expand their perspective and ensure connectedness by, for example, seeking coalitions with digital product and service providers and working toward a seamless integration. Furthermore, as we can especially see in the connected car case, our findings emphasize the overall need to engage in digital innovation even in industrial-age industries (Hanelt et al. 2021).

Second, our findings revealed the ambivalent relationship between connectedness and autonomy. Firms should be sensitive to potential skepticism or perceived threats of overdependence on the customer side. This awareness can be achieved, for instance, by providing and highlighting a kill switch-like option at any time that cuts all outbound linkages of the respective connected object. As connected objects also provide non-connectivity features (i.e., smart and physical features), devices should remain valuable even in offline mode. However, firms could also enable users to experiment with the connectivity features. As is common in digital business models, firms could grant free trials of connected objects or connectivity features. Our findings show that people experience autonomy satisfaction when using connectivity features. Thus, lowering the barriers to use might also alter attitudes toward them.

Limitations and Avenues for Future Research

Our work has several limitations, some of which offer promising avenues for future work in IS research. First, our work revealed that needs are associated with connectedness affordances. However, we did not differentiate levels of satisfaction. Possibly, people who excessively use connectivity features reach high levels of satisfaction, which might lower the importance of the respective need. Accordingly, this would indicate that the use of connectivity features would decrease. We can only speculate how different levels of satisfaction might actually play out, but we identify this topic as a promising area for future research. Furthermore, it could be interesting to examine how the use of different digital technologies or products and services together, or in other words, as an ensemble shape the users' satisfaction.

Second, we selected our research model in accordance with Karahanna et al. (2018), relating affordances to innate needs, and extended the model by including need satisfaction. Although other kinds of needs could have been selected, this complex model required some simplification. Future research could examine these proposed connectedness affordances also in relation to other needs-based theories than the self-determination theory. Furthermore, especially in the case of smartphone usage, this could be investigated under different scenarios, for example during leisure time or during working hours. Above all, future research also could examine relations between psychological needs and the connectedness affordances that were not hypothesized within this study.

Third, one key source to derive the features of the connected objects were the product descriptions of selected smartphone and car manufacturers. While focusing on market leaders and their products should yield a good sense of the most important connectivity features, we acknowledge that the number of connectivity features on the market is quite large and that individuals might also use other features that have the affordances as proposed in our need-affordances-satisfaction framework. Further research can take up this point by examining a broader set of features. Furthermore, we cannot fully exclude that there might be some kind of selection bias within the participants of the connected car case, as connectedness in the smartphone case is almost omnipresent while the participants who have cars with connectivity features presumably chose those cars based on a deliberate decision.

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Appendix

Table 1A. Survey Items Used in Questionnaires

Need for autonomy (Karahanna et al. 2018)	**Satisfaction of need for autonomy (Sheldon et al. 2001)**
I need to be able to decide for myself how to live my life.	When using my smartphone/connected car features, I feel…
I need to be able to freely voice my ideas and opinions.	that my choices are based on my true interests and values
In my daily life, I have the need to act freely.	free to do things my own way.
	that my choices express my "true self".
Need for relatedness (Karahanna et al. 2018)	**Satisfaction of need for relatedness (Sheldon et al. 2001)**
I feel the need to socially interact with people.	When using my smartphone/connected car features, I feel…
I feel the need to have a lot of social contacts.	a sense of contact with people who care for me, and whom I care for.
I feel the need to develop friendships with people I regularly interact with.	close and connected with other people who are important to me.
I feel the need to be close to many people.	a strong sense of intimacy with the people I spent time with.

Need for competence (Karahanna et al. 2018)	**Satisfaction of need for competence (Sheldon et al. 2001)**
I need to feel competent.	When using my smartphone/connected car features, I feel…
I need to feel capable in what I do.	that I am successfully completing difficult tasks and projects.
I need to have opportunities to show how capable I am.	that I am taking on and mastering hard challenges.
	very capable in what I do.
Overall satisfaction (McKinney et al. 2002)	
After using my smartphone/connected car, I am: very dissatisfied – very satisfied	
After using my smartphone/connected car, I am: very displeased – very pleased	
Using my smartphone/connected car made me: frustrated - contented	
After using my smartphone/connected car, I am: disappointed - delighted	
Using my smartphone/connected car is: will never recommend – will definitely recommend	
After using my smartphone/connected car, I: will never use it again – will definitely use it again	
Please indicate the extent to which you use each of the following…	
connected car features.	**smartphone features.**
Receiving information about points of interest	Supporting outdoor sports and fitness activities
Receiving real-time traffic information	Navigating
Connecting the smartphone to the car	Browsing online information and databases
Navigating	Streaming of audio and visual contents
Chatting with friends and family	Text-based communication with friends and family
Using digital radio stations	Video-based communication with friends and family
Receiving real-time notifications of current events	Shopping or ordering on the Internet
Streaming of music and audio books	Using social networks
Retrieving current weather information	Monitoring health conditions
Remotely accessing the car	Receiving real-time notifications of current events
Accessing vehicle data	Accessing and controlling other connected devices
	Searching for localized information
	Finding a local transport solution
	Playing online multiplayer games
	Using online banking and payment