Stay connected wherever you go - An instrument to measure connectivity

Ulrich Remus[1], Lena Waizenegger[2], Patrick Dippold[3]

[1]University of Innsbruck, Innsbruck, Austria, [2]Auckland University of Technology, Auckland, New Zealand, [3]ARZ, SAP Competence Center, Innsbruck, Austria
ulrich.remus@uibk.ac.at, lena.waizenegger@aut.ac.nz, patrick.dippold@arz.at

Abstract. Connectivity allows distributed teams that used to face challenges to collaborate easier with less spatial and temporal boundaries. At the same time, however, connectivity triggers negative consequences such as information overload, technostress and counterproductive work behavior if not managed carefully. While connectivity is often used as a metaphor for describing the technical infrastructure, this term is increasingly used in a variety of different disciplines and contexts. Yet researchers lack a reliable instrument to measure connectivity to investigate the various phenomena related to connectivity. To close this gap a robust multidimensional measurement instrument consisting of the sub-dimensions availability and responsiveness is developed. Its applicability and validity were demonstrated in two other field studies.

Keywords: availability, connectivity, instrument development, responsiveness

1 Motivation

Connectivity has drastically reshaped our professional and private lives [1, 2]. Distributed teams that used to face challenges such as huge travelling costs, lack of communication and coordination channels can now collaborate with less spatial and temporal boundaries [3]. Despite the many advantages, connectivity also leads to a lot of negative consequences such as information overload, technostress and constant interruptions [4–6]. Negative effects of connectivity are further exaggerated by a spiral of escalating engagement dictated by social norms and expectations, which can blur work-life balance, inhibit recovery after work and reduce well-being [7, 8]. While connectivity is often used to describe technical connections between electronic devices, this term has increasingly been applied in a broad variety of different disciplines and contexts also covering the social connections between people [3]. Despite the broad and frequent usage of the term, researchers still lack a reliable instrument to measure connectivity to investigate its antecedents and effects. To approach this gap a measurement instrument with its sub-dimensions availability and responsiveness was developed according to the multi-stage approach outlined by Schmiedel et al. [9] informed by best practices from other well-known sources, e.g., [10–15]. The goal was

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to develop a connectivity instrument, mainly applicable in the work context that allows further research to explore the impact of connectivity on typical work-related outcomes such as performance, efficiency, collaboration and socio-emotional side effects such as stress and burnout.

2 Instrument Development

Starting with a comprehensive literature review [16], as well as another empirical study [17] we were able to identify antecedents influencing individual perceptions of connectivity states. These are amount & direction (e.g., how many messages sent to whom and when), time (e.g., when, how often), content and context (e.g., location, situation, activity). A common theme, which emerged from these initial dimensions were underlying social norms and values that shape expectations towards the individual perception of availability and responsiveness [7, 8, 18]. These insights form the basis for developing definitions for our key concepts connectivity, availability and responsiveness as described below.

We define connectivity as being connected, available and responsive to one's social environment anytime and anywhere [18]. Availability is defined as the existence, reliability and potential of a connection [3, 20] between two individuals so that each individual is reachable by the other at access time [21]. For example, switching the status on instant messaging to "online", signals availability and therefore the potential to communicate. Responsiveness on the other hand is defined as the rate, timing and ability [22, 23] by which the potential of the connection [3] between two individuals can be activated by each individual. In other words, while individuals interact they develop expectations about when their counterpart comes back to them, which we call responsiveness. For example, answering a question in an email signals responsiveness.

In a next step, we conducted a revised literature review by drawing from existing research and extracting real-life cases from qualitative studies, focusing on connectivity literature addressing the issues around availability and responsiveness. We triangulated our findings by conducting semi-structured interviews and brainstorming sessions with students and employees experiencing availability and responsiveness to ensure that a vast majority of aspects are covered [10]. As a result, 23 items were created, that were then refined based on existing guidelines, such as avoiding double-barreled questions or stressed wordings (i.e. highly affective) that could introduce response biases [9]. Furthermore, the item pool was examined for items that were too narrow or specific in focus, redundant or ambiguous [13].

Then, 12 participants evaluated how well the items measure their respective category and provided further suggestions to improve the content validity of the items. Fourth, an index card sorting was executed. Ten participants were asked to sort the created items into the categories they deemed to fit best, otherwise, items were reworded and moved accordingly (91.7% of the items were placed correctly).

The final instrument was validated by conducting a pilot test with 38 participants using principal component analysis with oblimin rotation to assess whether the number

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of assumed underlying factors (availability and responsiveness) was correct. The corresponding Scree plot of the PCA confirmed the two-factor solution.

Finally, a survey was conducted that was distributed through the University list server and promoted in several social media networks, such as Facebook and LinkedIn. After data cleansing, the final sample consisted of 602 correctly completed questionnaires. 80% of the respondents were in the age group18-24. The vast majority of participants were students (90%), followed by employees accounting for 6.5 % and others (3.5%). A hierarchical component model was used and connectivity was modeled as a higher-order construct in a reflective-formative way [24, 25]. This model met all common validity and reliability criteria for assessing the outer reflective measurement model and the inner formative structural model. Indicators loadings between 0.4 and 0.7 were only deleted if deletion would increase the threshold of the AVE or CR over 0.5 or 0.7 respectively (no loadings < 0.6) [25]. With an AVE for availability of 0.499, we used a marginally lower threshold for availability, but due to content validity reasons and the explorative nature of instrument development we retained this solution [26]. Composite reliability for availability and responsiveness was well above the common threshold of 0.7. To assess discriminant validity between the sub constructs we used HTMT, which was below the most conservative value of 0.85. All criteria (multicollinearity, significant paths, Edward’s adequacy coefficient) for assessing the formative relationship of the exogenous lower order constructs and the endogenous higher order construct indicated a stable construct structure with 4 indicators each [14, 25].

Table 1. Items for availability and responsiveness

Availability	Responsiveness
If I don't have my mobile phone with me (and can't be contacted by colleagues), I consider myself completely disconnected.	If I answer incoming calls, messages or e-mails promptly, I see myself as highly connected.
If my device has a fast and stable connection, I see myself as strongly connected.	I expect colleagues to answer incoming calls and messages as equally fast as I do.
I expect my coworkers to show the same level of connectivity and reachability as I do.	If a project deadline is approaching I react to incoming calls and messages anytime to display high connectivity to my peers.
If colleagues react to my messages and calls in a short time, they are strongly connected to me.	When I contact colleagues after work they should have high connectivity and answer in a timely manner.

3 Post-hoc Validation and Application

So far, we conducted two studies to test the validity and rigor of the connectivity instrument. The first study investigated the relationships between connectivity, past emotional and cognitive overload [27] and actual information and communication overload [27] to further advance our knowledge around techno overload [28]. For this study, a convenience sample was drawn, and participants were invited to participate through various social media channels. In total, 88 men and 62 women with various

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occupations completed the survey. The majority of participants were between 20 and 29 (59.3%) and between 30 and 39 (26.7%). 14% were older than 40. The second study investigated the interplay between personality traits, connective behavior and stress. This survey involved a larger sample and mainly involved students, and to a lesser extent professionals. However, it still had a large enough sub-sample size, to assess whether the instrument behaves equally well across several demographic groups. Again, the link to the survey was sent to the University's own list server. An additional 125 questionnaires were gathered via e-mail, different social media platforms or in person resulting in 470 records after data cleansing. 70.8% were female and 29.2% male. The majority of participants were in the age group 18 - 24 (66.3%), 22.8% were between 25 and 31 years old, and only around 10.9% were older than 32. The sample consisted of 77.5% students, 20.4% professionals and 2.1% others.

To test the reliability and validity of the instrument, we conducted the same tests outlined in the validation phase. In both studies, no single item had to be deleted. In the first study, all items had high loadings (between 0.76 – 0.86). Cronbach Alpha (AV: 0.86, RE: 0.79), AVE (AV: 0.62, RE: 0.69) and Composite Reliability (AV: 0.90, RE: 0.87) were well above common thresholds for explorative research. Further analyses for the validity of the second-order structures showed equally robust results. Connectivity explained around 16% of the variance in information overload, and 20% of communication overload and had significant effects on communication overload ($p<0.01$) and information overload ($p<0.05$) respectively.

In the second study, the indicator loading and AVE for responsiveness were a bit lower than in the first study (loadings 0.63 - 0.87; AVE 0.52). All other measures, such as Cronbach Alpha and Composite Reliability performed equally well as in the first study. Connectivity explained around 22% of the variance in the target construct 'stress' showing a highly significant effect ($p< 0.001$). We also controlled for heterogeneity by splitting the sample into students and employees, and across several age groups. Here the subsample consisting of employees showed even better results (increased R^2, higher Cronbach Alpha and AVE), suggesting that the connectivity instrument performs equally well or even better for employees than for students.

4 Limitations and outlook

One of the limitations is that several demographic groups were overrepresented in the instrument development study, which might have introduced participant-selection bias based on different social and educational backgrounds [9]. However, particularly the employee subsample in the validation study showed equally robust results in terms of validity and reliability of the instrument. Please note that due to using the same list server for inviting study participants the samples for the instrument development and one of the validation studies could have overlapped to some extent.

In conclusion, the measurement instrument has already been successfully applied to investigate the effects of connectivity on outcomes such as technostress and well-being, but we want to encourage further studies to explore the impact of connectivity on other work outcomes such as work engagement and task performance.

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