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Towards a Greater Diversity of Replication Studies

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Abstract:

The replication of existing knowledge (e.g., previous study results) stands as an essential research practice across all science disciplines. Despite the importance of replication, the scarcity of replication studies is commonly criticized in business, management, and information system (IS) research. Therefore, efforts have already been made to facilitate replication research in the IS community, such as establishing conference tracks and journals focusing on publishing replication studies and providing guidelines on how and why to conduct replication research. Nonetheless, the perception of replication research remains unchanged, describing it as mundane.

Therefore, in this issues and opinions article, we will explore how replication research could be made more appealing by diversifying the categories of replication studies. In this regard, we looked at replication in neuroscience, eliciting two new replication study categories: 'transfer' and 'method.' Additionally, through extensive discussion with other IS scholars, we added one more replication category, 'comparison.' We hope that this diversification will attract more researchers and also show the potential replication research holds.

Keywords: Replication Research, Replication Study Categories, NeuroIS, Neuroscience, Literature Review

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1 Introduction

Replication research, being the replication of research results, stands as an important research practice across all science disciplines (Dennis & Valacich, 2014; Gómez et al., 2010; King, 1995). The replication of results converts tentative belief into accepted, tested, and dependable knowledge (Berthon et al., 2002). Hence, replication is a powerful concept for scientific progress by reinforcing the foundations for new advancements and discoveries (Schmidt, 2009).

Despite its importance, the rarity of replication research remains a major weak point and is commonly criticized in business, management, and IS research (Berthon et al., 2002; Dennis & Valacich, 2014; Hart & Gregor, 2012). Other disciplines are also struggling with a lack of replication research. In this context, Baker (2016) investigated reproducibility in various disciplines (chemistry, biology, physics, engineering, medicine, and environmental studies) by questioning over 1,500 researchers. Around 90% of researchers perceive science to have at least a slight reproducibility crisis. The term "reproducibility crisis" describes the problem that many empirical studies' results are impossible or at least challenging to reproduce by other researchers or the original study's authors. A replication crisis calls into question how studies are conducted, how they are presented, and the validity of results (Fanelli, 2009). Thus, an increase in replication research is desirable in many disciplines, including IS research, to strengthen existing knowledge and the theoretical base from which new studies start.

Efforts to facilitate replication research in the IS community have already been made, ranging from providing better guidelines of how and why to carry out replication research (Dennis & Valacich, 2014) to establishing conference tracks and journals focusing on publishing replication studies (AMCIS, 2018; TRR, 2018). Nonetheless, replication research remains a rarity in IS research (46 total published replication studies in the basket of eight journals, AIS Conferences, and AIS Transactions on Replication Research up to October 2018). We would argue that this is partly caused by the common perception of replication research to be mundane and boring (Lindsay & Ehrenberg, 1993). Replication research is perceived to be unable to provide interesting theoretical contributions, hindering replication studies from being published in well-regarded outlets (e.g., reviewers and editors are biased against publishing replication studies) (Dennis & Valacich, 2014).

This challenge has been addressed in various ways in several disciplines. Recommendations include teaching the importance of replication and reproducibility (Frank & Saxe, 2012), pre-registration of studies (Simons et al., 2014) and sharing studies data online (Ioannidis, 2016). Similarly, researchers are called to conduct replication studies in the IS community by highlighting the value of replication research (e.g., Dennis and Valacich 2014; Niederman and March 2014). However, the quest to find ways to make replication research more appealing still seems unsolved, needing further investigation. Against this background, this article aims to address the question of:

How can we make replication research more appealing to conduct and publish?

We want to address the misconception that replication studies have to be exact replications of the original and are thereby perceived as boring (Lindsay & Ehrenberg, 1993). In order to contribute towards making replication research more interesting and appealing, we approach it by trying to learn from other disciplines, which have a more pronounced replication culture. To be specific, we analyzed the discipline of neuroscience in this paper.

The replication culture of neuroscience distinguishes itself from others because neuroscience is the interface between psychology, biology, and medicine (for a review on the emergence of neuroscience as a field of its own right, see Cowan et al. (2000)). From these disciplines, psychology has been the most affected by the so-called replication crisis (Open Science Collaboration, 2015) and has the problem of hard-to-control experiment parameters and context of an experiment (Stroebe & Strack, 2014). Neuroscience, classified as natural science, also utilizes well-defined experimental settings, which are much easier to be replicated. Neuroscience explores the biological basis of psychological hypotheses and theories. This exploration necessitates a replication of previously observed original behavioral findings to correlate them with neural recordings. Additionally, since neuroscience utilizes a plethora of different methods (e.g., imaging or electrical recordings), each with their limitations, a phenomenon cannot be fully understood with just one experiment and has to be replicated by a different group with different methodological strengths to be thoroughly investigated. Lastly, the neuroscience community acknowledges the need for replication (Kellmeyer, 2017; Steckler, 2015) and actively promotes the publishing of replication studies in all their journals (Bernard, 2016). In sum, we believe that IS can learn from neuroscience since it is also applying methods and theories from other disciplines (e.g., psychology, computer science, economics).

The relatability of neuroscience to IS research can also be seen in the emerging research field of NeuroIS (Mamun et al., 2018; Riedl et al., 2017). To give an example of such interdisciplinary research, Dimoka et al. (2011) investigated a brain area known as the dorsolateral prefrontal cortex (DLPFC) and its association with the perceived ease of use of an online shopping website in a functional magnetitic resonance imaging (fMRI) experiment. Subsequent publications aimed to replicate those findings but utilizing different methods, such as transcranial direct current stimulation (Dumont et al., 2018) or functional near-infrared spectroscopy (Nissen et al., 2019). Both subsequent experiments failed to replicate the finding of Dimoka et al., calling the initial results into question. Nonetheless, it is possible that the original study is the one that was correct or that the two studies point to a contingency such that both are correct but under somewhat different conditions. The point of the replication is not to settle with only one being “correct.” Against this background, conducting replication studies with various methods to investigate original findings is highly valuable for scientific progress.

In the remainder of this article, we will first provide a brief introduction to replication research. Second, we will present the observations and conclusions we made when analyzing replication studies from the field of neuroscience (see Appendix for details). Third, we discuss our findings to elicit implications for the IS community. Last, a brief conclusion is drawn, including a call for action.

2 Replication Research

Replication research aims to enable a scientific consensus on the proposed knowledge by testing the validity of previous studies (Berthon et al., 2002; Dennis & Valacich, 2014; Schmidt, 2009). Hence, the aim is to investigate the ability to generalize and strengthen existing knowledge. Thus, replication studies contribute to theory by supporting or questioning the understanding of certain phenomena and research areas (Dennis & Valacich, 2014; Niederman & March, 2014).

Following Popper (1959, 1963), theories must be possible to falsify, and theories can only be refuted and never confirmed. Thus, the scientific progress consists of (1) proposing a theory, (2) trying to refute the theory, (3) improving or replacing theory to explain the investigated phenomena better (Salovaara & Merikivi, 2015). In this context, replication research primarily addresses the second step of the scientific progress and tries to refute existing theories, which leads to strengthening theories that withstand refutation attempts (Figure 1 illustrates the process and the position of replication research).

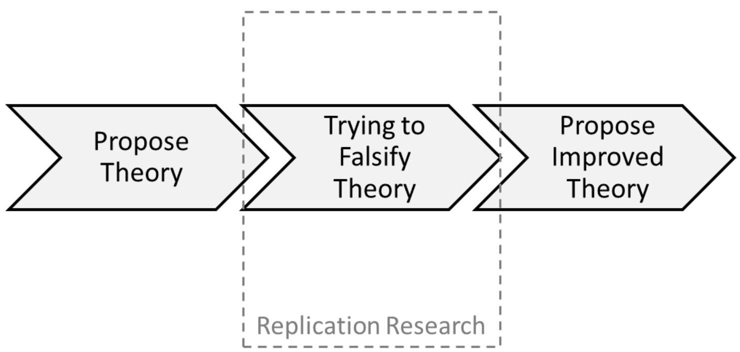


Figure 1: Process of Falsification

In this context, replication studies can address different parts of a study. To be specific, replication studies can lead to at least one of the following five outcomes (Schmidt, 2009):

(1) Finding sample errors means to search for results that were obtained based on incorrect data. The original study is replicated as closely as possible, with a new sample with the same characteristics as the original study. The original method (commonly statistical test) is repeated, i.e., the original study’s p-value(s) by which hypotheses were supported or rejected initially. For example, in case the chance of a false-positive result is $p=0.05$ in the original study, a positive replication study (e.g., also $p=0.05$) leads to a lower p-value overall ($p= 0.05 \times 0.05 = 0.0025$), making chance results (e.g., sample error) doubtful (Schmidt, 2009).

(2) Controlling for lack of internal validity is important to rule out external variables that interact with the study design and results (Schmidt, 2009). Overall, it is concerned with "whether the researcher provides a plausible causal argument, logical reasoning that is powerful and compelling enough to defend the research conclusion" (Gibbert et al. 2008, p.1466).

(3) Uncovering fraud addresses the problem of human interference in the reported results. Although journals and conferences require authors to comply with their codes of research conduct, fraud cases have been observed in the past (Wilmshurst, 2002). The original study is replicated as precisely as possible to identify any deviations in results, which are caused by potential human interference (e.g., fraud) (Schmidt, 2009).

(4) Expanding or generalizing results to cover a larger or different context addresses the generalization of initial results across population and time. Against this background, a replication study is conducted to investigate whether the original results are specific to a certain population or context (Schmidt, 2009). To give an example, a common discussion in the literature addresses whether university students are a valid subject group for certain research (Compeau et al., 2012). Hence, replication studies can be conducted to verify a study conducted amongst a student population by replicating it with non-student data. This increases the scope of the original study.

(5) Verifying original hypotheses means to provide hypothesis-conformation or hypothesis-disconfirmation for an existing theory by repeating previous investigations (Snyder & White, 1981). To verify a behavioral research hypothesis means to reach beyond the function to support results by repeating the original experimental procedure. This means that a replication study follows different experimental arrangements, designed to independently reconsider the original study's hypothesis (Schmidt, 2009). Hence, the aim is to investigate the prior thinking and respond appropriately based on findings. Thus, the theoretical contribution lies in the iterative improvement and elaboration of an existing theory, supporting them with empirical results or refuting them because of contrary replication results (Compeau et al., 2012).

A variety of replication approaches and types have been advanced over the years (Berthon et al., 2002; Dennis & Valacich, 2014; Gómez et al., 2014). The most prominent categorization in the IS research community is from Dennis and Valacich (2014):

(1) Exact replications share the same context and method with the original study. All treatments, methods, and measures are identical to the original research. Furthermore, the context remains the same, so if the original study used employees of a Chinese automotive company, the replication study would do so as well (Dennis & Valacich, 2014).

(2) Methodological replications apply the same method as the original study but in a different context. For instance, this means that instead of employees of a Chinese automotive company, the replication study might use German undergraduate students (Dennis & Valacich, 2014).

(3) Conceptual replications investigate the same research questions via different means or context. Thus, they seek to answer the same research question testing the same hypotheses but with different measures, treatments, contexts, or analytical methods. For example, in the replication study, the wording of items used to measure key constructs might be altered (Dennis & Valacich, 2014).

3 Three New Replication Study Categories

To find ways to make replication research more appealing to conduct and publish, we looked at the discipline of neuroscience (see Appendix A for the research approach and Appendix B for a detailed summary of analysis results). When looking at studies from neuroscience, we discovered that not all studies fall into the categories provided by Dennis and Valacich (2014). Besides exact, method, and conceptual replication, we found more study categories (see Table 1 for a summary of current and additional study categories).

Transfer replications are studies that apply a similar method as the original study to test the original (or very similar) hypotheses in a different context. Such a study primarily tests the boundary of a theory – does it extend into this additional domain, or does it apply only within its previous bounds? Specifically, the goal is not to change, extend, or add to the existing theory, but rather to test or increase its external validity and transferability to other contexts. An example is the study of Blizzard et al. (2016). Their study explored lower motor neuron degeneration after spinal cord injury, which was originally explored by using the same method on the subject of the model organism "rat." In the replication study, the subject was changed to be the model organism "mice," and the method was adapted accordingly. When looking into IS literature, we found the study of Xu et al. (2012) to be a somewhat fitting example (Note, it does not fit perfectly and would suggest that a perfect fit has yet to be found). In this study, the authors transferred the model of Malhotra et al. (2004) regarding users' information privacy concerns to the context of smartphones. For this, they had to adjust their applied instruments.

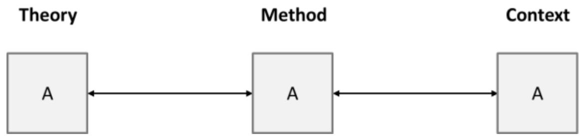
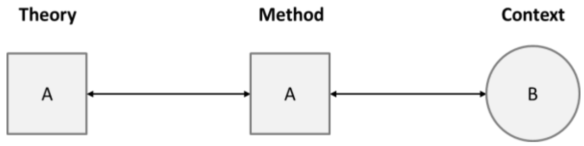
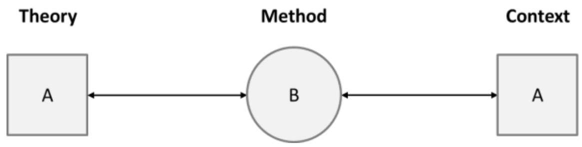
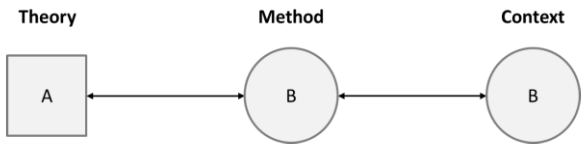
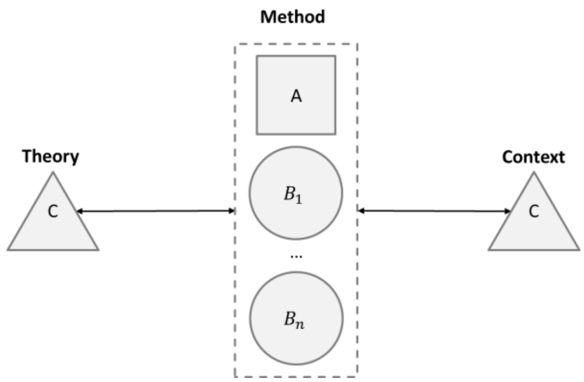
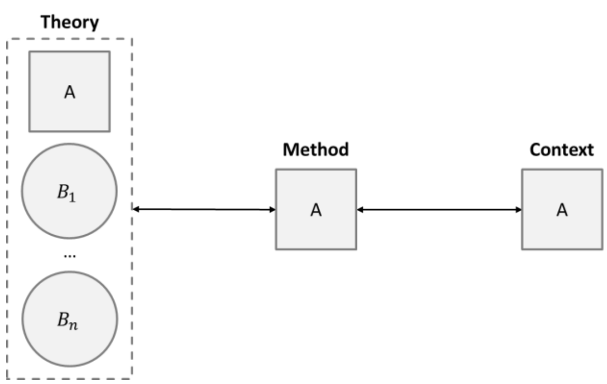
Method Replication studies aim at validating existing methods by using a dataset that is either simulated or has a known ground truth. Often, two methods are compared to see which of them is more suited to a given task under given boundaries and requirements (e.g., efficiency or precision). By using a dataset that has a known result (e.g., correlations are present or distinctly not present – either naturally or artificially), the methods can be compared. For instance, if a method finds a correlation where none should be found, the method's validity can be called into question. Those studies are imperative for natural science research, since knowing the strengths and limitations of a method is vital in judging the original research results. A good example is Tudorascu et al. (2016), in which the authors compare two popular programs used for functional magnetic resonance imaging analysis. In the context of IS research, this potential approach to replication research seems to exist (e.g., Kim and Malhotra 2005) but lacks recognition as a replication study category so far.

We presented the previously described study categories at the Americas Conference on Information Systems 2019 conference (Greulich & Brendel, 2019), which were well received. Nonetheless, when discussing the completeness of the new set of replication categories, an additional category was proposed by the plenum:

Comparison replication studies try to compare theories to validate their claims to explain a given context adequately. Specifically, there can be competing theories, explaining a similar phenomenon based on a different set of assumptions. For instance, the technology acceptance model (TAM) (Davis, 1989) and the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003) both address technology acceptance via a different conceptualization and level of complexity (van Raaij & Schepers, 2008). Through a comparison replication study, researchers could be provided with evidence for selecting one or the other theory to explore a new context. Similar to method replication, studies falling into this category can also be found in IS research (e.g., Trang et al. 2014) but are not considered part of the replication research spectrum.

Lastly, we would like to acknowledge that transfer replications can be categorized as a sub-category of conceptual replications (Dennis & Valacich, 2014). The category of conceptual replications includes all studies that alter the applied method. Furthermore, the context can be changed, but such a change is not necessarily considered a conceptual replication. Based on this consideration, a second sub-category can be distinguished besides transfer replications:

Context Replication studies apply a different method to test the original (or a very similar) hypotheses in the same context. Such a replication aims to investigate whether the original theory or results are valid or a product of the applied method. Hence, a context replication study addresses the method validity and potential biases of the original research team during the selection and application of the method. An example would be the study of Mitchell and Zheng (2019), in which the original method of an experiment in a lab environment was replaced with an experiment in a classroom environment, which necessitated some changes to the original procedures.

Name		Depiction	Description	Reference or Example
Exact			Replicating the same theory or results (A) via the same method (A) in the same context (A) as the original study.	(Dennis & Valacich, 2014)
Methodological			Replicating the same theory or results (A) via the same method (A) in a different context (B) as the original study.	(Dennis & Valacich, 2014)
Conceptual	*Context*		Replicating the same theory or results (A) via a different method (B) in the same context (A) as the original study.	(Dennis & Valacich, 2014) (Mitchell & Zheng, 2019)
	Transfer		Replicating the same theory or results (A) via a different method (B) in a different context (B) as the original study.	(Dennis & Valacich, 2014) (Blizzard et al., 2016; Xu et al., 2012)
Method			Replicating a known* theory or results (C) via different methods (A and B) in a known context (C) to validate the original method (A).	(Kim & Malhotra, 2005; Tudorascu et al., 2016)
Comparison			Comparing the same theory or results (A) with alternative theories or results (B) via the same method (A) in the same context (A) as the original study.	(Trang et al., 2014)

Legend: A (rectangle) = same as original study; B (circle) = different from original study; C (triangle) = known and different to original study
*Note "known" means that the relation of theory and context has been well supported via various means.

Table 1: Replication Study Categories Comparison

4 Discussion

This paper aimed to contribute to making replication research more appealing. In this context, we elicited replication study categories from the field of neuroscience and compared them with the common replication study categories from the IS field. Through the comparison, it appeared that the study categories transfer, context, method, and comparison replication are currently not recognized (see Table 1). In an effort to broaden the range of approaches available to scholars for replication research, we offer additional categories within which such research can be designed and executed. They provide transparency regarding the specific contributions that replication research can offer to the IS community. By defining them, we believe that researchers can better position and justify their replication research.

Firstly, a transfer replication study transfers existing theories in a new context, investigating existing theories' capabilities and limitations. Thereby, transfer replication studies can provide a foundation of subsequent studies, addressing how existing theories should be adapted to overcome limitations and eventually helping to understand new phenomena. Hence, conducting a transfer replication study can take some pressure off these studies by already transferring existing theories and highlighting areas for adaption. In the context of IS research, which is characterized by rapid changes caused by technology (Easley et al., 2000; Niederman & March, 2014), it is crucial to reevaluate and adapt theories to stay relevant and accurate iteratively. This also includes evaluating whether the scope of theories is decreasing or expanding. Hence, before developing entirely new theories, conducting transfer replication studies can reveal where existing theories remain relevant in IS research. Furthermore, this approach would greatly fit within the scientific process proposed by Popper (1963). Before proposing a new theory, replicating, and possibly refuting existing theories can be an excellent means to sharpen the outlines of research gaps and the eventual contribution of a study. In sum, we see great potential in conducting transfer replication studies in the IS community.

Secondly, a method replication study seeks to verify a method by either comparing it to other established methods, applying it to a dataset with known ground truth (e.g., from a simulation), or both. This is different from the methodological replication proposed by Dennis and Valacich (2014), where the original study is replicated with the same method but in a different context. However, this does not question the ability of the method to get the correct results. Since the different contexts could cause differences in the outcome, and if the method is itself flawed, it might lead to erroneous replications. Hence, we see the method replication study category as an integral part of proper scientific work, which can help rule out flawed methodology as a cause for failed replications.

Thirdly, comparison replication studies promise to be a valuable means to direct researchers in identifying theories for extension or even developing new theories. These replication studies do not only replicate the addressed theories individually but try to compare them in order to elicit differences and sharpen limitations. This comparison process is especially important because often various theories can be applied to explain similar behavior. For instance, motivation can be explained following various theories, ranging from the self-determination theory over goal orientation theory to attribution theory (Cook & Artino, 2016). Based on the results of a comparison replication study, future research can better articulate and justify selecting a specific theory for a particular context.

5 Conclusion

We are not the first (e.g., Dennis and Valacich 2014; Niederman and March 2014; Salovaara and Merikivi 2015) and hopefully not the last to call for more replication research in the IS research community, making an effort to change our perception regarding the value of replication research. In order to provide a more interesting replication study landscape, we propose three additional replication study categories: (1) transfer, (2) method, and (3) comparison.

In this context, comparing each replication study category's scope should spark the question: what constitutes a replication study and differentiates it from "regular" research? Specifically, the replication study category of transfer replication triggers this question. "Borrowing" theories by transferring them from other disciplines or topics to explain other phenomena is a standard procedure and necessary to appropriately approach the phenomena to be investigated (Moeini et al., 2019, 2020). One example in this context is the reapplication of the technology acceptance model, which has been proven to provide a foundation to approach technology acceptance in various contexts (Salovaara & Merikivi, 2015).

Thus, there needs to be a differentiation between reusing and replication of a theory. Based on our sample of neuroscience replication studies and our understanding of replication research, we argue that the differentiating factor is the research question and goal of the researchers conducting the study. A purist view on replication dictates that replication research should be conducted as closely as possible to the original study because deviations can lead to multiple results derived from ambiguous sources. In contrast, we advocate the more liberal approach to understanding replication research. We see the study's orientation as decisive. If a study is oriented towards existing knowledge (i.e., trying to verify and validate results and theories that already exist), it can be considered a replication study. Contrarily, a study that is oriented towards new knowledge (i.e., actively trying to extend an existing theory, develop new theory, and explain new phenomena) has to be classified as "regular" research. In that regard, a transfer replication study has a clear focus on existing theory. Nonetheless, a transfer study showing the limits of existing theories is a great reason to ask why the theory could not explain the phenomena. Due to this, we see a transfer study as a link between pure replication research and "regular" research. Overall, it extends the replication goal of expanding or generalizing results to cover a broader or different context (Schmidt 2009) by actively seeking contexts that are not very similar to the original.

Overall, we would like to call on the IS community to conduct and value replication studies so that in addition to creating or borrowing theory, we are engaged in constant improvement. Thus, we would increase our body of theory and have higher levels of confidence where they are supported and opportunities to investigate nuanced variations in the environment, which translates to higher knowledge in applying theory. We call on the IS research community to embrace this element of creating a more reliable, more robust, and more useful body of knowledge.

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Appendix A: Literature Review Approach

We base our research approach on the literature review approach, specifically on the seminal works of Webster and Watson (2002) and Vom Brocke et al. (2009). Following the taxonomy of literature reviews of Cooper (1988), we designed our research approach to conduct a literature review of the following characteristics:

Focus – Practices and Applications: Our literature review focuses on research practices and applications in replication research.

Goals – Integration: Our literature review aims at integrating replication research practices from the field of neuroscience within the IS research domain. Hence, the aim is not to critique. We want to look at how to make replication research more approachable and appealing – and there is nobody at fault for the lack of attractiveness.

Perspective – Neutral Representation: The literature review is supposed to provide a neutral analysis of categories of conducted replication studies and what we can learn from them.

Coverage – Representative: The selected literature is supposed to be a presentative sample of replication research in neuroscience.

Organization – Conceptual: A conceptual perspective is required to identify categories of replication studies and therefore applied in our literature review.

Audience – General Scholars: The literature review is presumed to provide insights into replication research practices that are interesting for the entire IS community.

The research approach has three phases to enable the conduction of the previously described literature review:

Phase 1 –Review: *How is replication research carried out in neuroscience?* In this phase, replication studies from the field of neuroscience were reviewed to identify replication study categories and practices in neuroscience.

Phase 2 – Comparison: *How does replication research in neuroscience differentiate from replication research in the IS community?* In the second phase, seminal works on replication research are reviewed and matched with the first phase's results to achieve a coherent and complete picture of the status quo.

Phase 3 – Interpretation: *What are the implications for the IS community?* In the last phase, the similarities and differences of replication studies are interpreted to elicit implications on making replication research more appealing for the IS community. This is also the phase where we asked other scholars to review our conclusions and allowing us to reflect on and refine our interpretations.

The individual phases' steps and relations are illustrated in Figure A1 and are described in the following sub-sections.

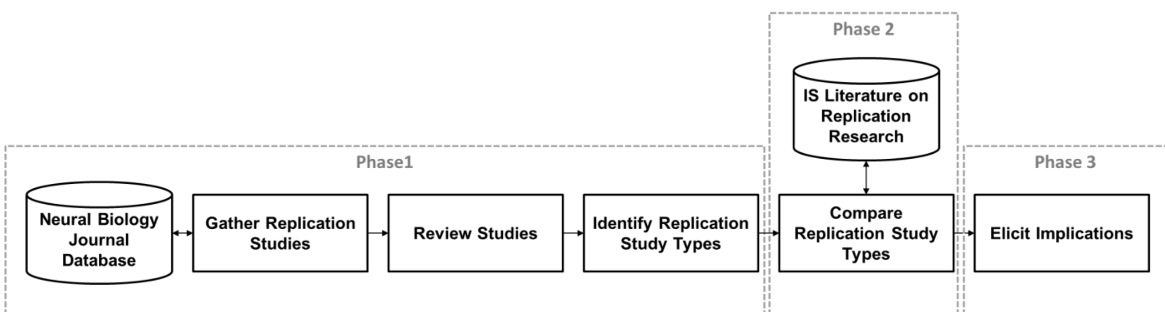

Figure A1: Research Process

Phase 1: Review of Replication Studies in Neuroscience

In the first phase, two points guided us to select the field of neuroscience as a reference point for finding aspects to make replication research more appealing. Firstly, as discussed in the introduction, neuroscience has an influential replication culture. Secondly, one of the authors is a researcher in the field of neuroscience. This is especially beneficial, as understanding the field and methods used is essential to judge a paper's content.

Based on the author's experience in neuroscience, we decided to select an open-access neuroscience journal for our literature search. This decision was made because replication studies are often considered not to be innovative enough for the traditional journals (showcasing that even the neurosciences are still suffering some shortcomings in replication research). Thus, the neuroscience community is actively promoting open access to combat this publication bias (Koch and Jones 2016). According to the 2016 Journal Citation Reports (Journal Citation Reports 2016), the most cited neuroscience open access journals are first "Frontiers in Human Neuroscience," second "Frontiers in Cellular Neuroscience," and third "Frontiers in Neuroscience." To ensure the review of a representative cross-section of the field, we picked the "Frontiers in Neuroscience" journal. However, this had the unfortunate side effect that it was impossible to use a keyword search to get replication studies.

The literature search was conducted in 2017, and we decided to include all publications of 2016 in our search (each year has a volume of around 722 publications), providing the manageable number of 631 publications for our filtering process. During the search, a two-step approach was applied. Firstly, the author, with a background in neuroscience, identified studies via title and abstract. The articles were filtered by two of the authors, one with a Ph.D. in IS and one doctoral candidate in neuroscience. We reviewed the titles and abstracts of this selection for replication studies. Studies that presented novel results were excluded, as were review articles. We exclusively included articles that specifically replicated previous research. Eventually, the sample was reduced to 59 articles. Those articles were then reviewed in depth over a full year, leading to the exclusion of another five articles.

Phase 2: Comparison of Replication Study Categories from Neuroscience and Information Systems Research

Based on the results of the first phase, we compared the elicited replication study categories with the replication study categories of IS research. In this context, we decided to follow the replication study categories used in the AIS Transactions on Replication Research journal (Dennis and Valacich 2014; TRR 2018). In that regard, both authors revised the previously made categorizations and compared them to the categories found in the IS community.

Phase 3: Interpretation of Differences and Elicitation of Implications

In the last phase, we interpreted the differences in replication categories by reflecting on what the differences can mean for future replication research. To be specific, we compared the falsification process by Popper (1963) and which roles the newly developed replication categories can play within it.

Appendix B: Literature Analysis

While going through our literature set, we found five different categories of replication studies (see Table B1), which we will describe in the following.

Studies in the first category retest the same hypothesis as the original study, using the same method, which can be called **exact replication** (Dennis and Valacich 2014), as the original research is repeated as closely as possible. For example, the study of Morrison et al. (2016) investigates the reliability of fMRI brain mapping before implantation of direct brain stimulation devices (DCS). Here, several studies already exist but are often marred by small sample size as the number of available patients per brain surgery center is limited. Hence, the study adds to an existing body of work with the same methods to better evaluate the previously reported effects. In total, we found three studies of this kind.

The second category retests the same hypothesis as the original work, sometimes with an extension, but follows a different method. Hence, these studies can be called **context replications**. Such studies aim to ensure that the previous results are not caused by misuse or unsuitability of the original method. For example, Coutlee et al. (2016) are retesting the involvement of the intraparietal sulcus (ISP) in risk evaluation, which was shown by fMRI. The authors expose subjects to the same risky-choice task as the original study, but after the IPS was disabled with transcranial magnetic stimulation. In total, we found ten studies for this category.

Name	Hypothesis	Method	Model	#	Example
Exact	Identical	Identical	Identical	3	Morrison et al. (2016)
Conceptual	Identical (sometimes extended)	Different	Identical	10	Coutlee et al. (2016)
Methodological	Identical	Identical	Different	11	Blizzard et al. (2016)
Transfer	Identical	Different	Different	5	Raffa et al. (2016)
Method	Identical	Comparing different methods for the same outcome or against ground truth	Identical or simulated with known ground truth	25	Tudorascu et al. (2016)

Table B1: Elicited Replication Research Categories

In our third category, studies investigate a similar context compared to the original study and apply the same methodological approach. In this context, similar means that the replication study authors try to find the same results as the original study, but in a different context. Hence, this study category can be called **methodological replication**. An example is the study of Blizzard et al. (2016). In their study, they explored lower motor neuron degeneration after spinal cord injury, which was originally explored by using the same method on the subject of the model organism “rat.” In the replication study, the subject was changed to be the model organism “mice.” Overall, we found 11 studies for this category.

We called the fourth category **transfer replication**. Transfer studies use the same method but to test a different yet similar hypothesis, emphasizing that the hypothesis is similar to the original one. For example, Raffa et al. (2016) uses a well-established method for preoperative trace motor circuitry in brain cancer patients and attempts to trace the language circuitry. This firstly retests the used method and secondly, the underlying assumption that both hypotheses are similar enough. In total, we found five studies for this category.

Lastly, some studies have the aim of **method replication**. This is often done using a dataset that is either simulated or has a known ground truth and is then explored with the method. Often, two methods are compared to see which of them is more suited to a given task. Those studies are imperative for natural science research, since knowing the strengths and limitations of a method is vital in judging the results of original research. A good example is Tudorascu et al. (2016), in which the authors compare two popular programs used for fMRI analysis. We found 25 examples.

About the Authors

Alfred Benedikt Brendel was an assistant professor ("akademischer Rat") at the University of Goettingen, Germany and has been appointed professor at the Technische Universität Dresden in October of 2020 and holds the chair for business informatics, esp. intelligent systems and services. Alfred received his Doctor's degree in management science, specializing in Business Information Systems, from the University of Goettingen. His research focuses on the application of Design Science Research to develop novel and innovative design principles and theories. His main areas of research are digital health, smart mobility, and persuasive system design. His research has been published in the proceedings of leading conferences, such as the *International Conference on Information Systems* and *European Conference on Information Systems*, and journals, such as *Business & Information Systems Engineering* and *Information Systems Frontiers*.

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