

REVIEW

Changing research culture toward more use of replication research: a narrative review of barriers and strategies

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Abstract

Objective: The aim of this paper is to review the literature on barriers to conducting replication research and strategies to increase its use and promotion by researchers, editors, and funders.

Study Design and Setting: This review was part of a larger meta-narrative review aimed at conducting a concept analysis of replication and developing a replication research framework. A combination of systematic and snowball search strategies was used to identify relevant literature in multiple research fields. Data were coded and analyzed using the Theoretical Domains Framework for barriers to replication and the behavior change wheel for solutions.

Results: In total, 153 papers were included in this narrative review. Multiple barriers limit the use of replication research by researchers, editors, and funders. Many of the barriers were related to knowledge and skills of all these actors. Social influences and the research environmental context were also described as not supportive. Multiple strategies were proposed to create positive outcomes expectations, reinforcement, and structural changes in the physical and social context of research.

Conclusion: A social change involving advisory groups, research organizations, and institutions is required to establish new norms that will value, promote, support, and reward replication research. © 2020 Published by Elsevier Inc.

Keywords: Replication; Reproducibility; Barriers; Narrative review; Research methods; Quantitative research

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What is new?

- Multiple barriers deeply rooted in the culture of research limit the conduct of replication research.
- Social influences, environmental context, reinforcement, knowledge and skills are all inter-related factors influencing researchers' behavior in regard to replication research.
- Editors and funders can promote and provide opportunities and conditions to increase use of replication.
- Strategies found in the literature suggest that a social and community change is required to address these multilevel barriers.

1. Introduction

A replication study is a deliberate repetition of a previous study in whole, in part, or conceptually to demonstrate the reproducibility, validity, and generalizability of research results or theory over a specified range of instances and contexts [1–4]. However, replication studies remain unpopular and undervalued within the culture of multiple research fields. Hunter [5] suggested that the unpopularity of replication stems from the combination of two errors: the use of creativity as one of the main criteria for quality and the wide-spread belief that single studies establish valid and robust findings that are sufficient to change practice or policy. However, single studies are seldom sufficient to singularly inform practice or policy decisions [4–6]. As illustrated by Schmidt [6], a cumulative science should be built on its foundations in a systematic way: “Adding a brick here and another brick there without much regard for the space between them may result in an unstable building with weak parts, leakages and unnecessary parts that will require a major effort later on to effect their removal.”

There are few replication studies published within the health, education, social, and business science literature [6–11]. Multiple barriers, deeply rooted in the culture of research, exist which hinder appropriate replication of research findings and trap researchers, editors, and funders in a cycle that actively promotes and favors novel studies to the detriment of replication studies [12–14]. Over the years, multiple solutions and recommendations have been proposed to promote the conduct of more replication research [11,14,15]. We undertook a narrative review [16] of barriers to replicating research and strategies to increase replication, using rigorous search and data appraisal strategies, to foster greater recognition of the problems associated with changing research practices and formulating recommendations for the future.

2. Methods

This study is a secondary analysis of data collected while conducting a meta-narrative review on the concept of replication research [4]. The meta-narrative review approach was used to guide the search and data extraction process. However, a deductive thematic analysis approach was used to synthesize the data collected on barriers and strategies. We used a combination of snowball search methods and a systematic search of different databases (including PsychInfo 1848 [OVID]; CINAHL 1980 [EBS-CO]; Medline 1948 [OVID]; EMBASE 1980 [OVID]; ERIC; and Worldcat) to gather the literature from multiple fields of research (health, business, social science, education, psychology, science/math). The first systematic search was conducted by an information specialist (M.F.) to find papers published on replication research until 2013 and an updated search (forward search of the 5 most cited papers) was then performed to find relevant manuscripts published between 2014 and April, 2018 (B.V., J.A.C.). A paper was included in the review if it (1) provided a clear definition of the concept (replication research or surrogate term—reproducibility, replicability, repetition) and (2) described different assumptions related to replication and its importance in various research domains. Replication studies that did not discuss the concept of replication, and papers published in languages other than English and French were excluded. More details on the search strategy are available from a previous paper [4]. Searches were screened independently by two assessors (B.V., J.A.C., S.K., and two research assistants). Papers were uploaded in NVivo software.

We extracted information from each paper describing barriers and strategies proposed by their authors to enhance use of replication research. Two independent reviewers (J.A.C., B.V.) carried out deductive thematic analysis [17]. The Revised-Theoretical Domains Framework (TDF) was used to guide coding and classifying data on barriers [18,19]. This framework is composed of 14 theoretical domains identified through a synthesis of 33 behavior change theories that can be applied to understand behavior change [18]. We extracted the data on barriers from the papers and then classified it within each revised-TDF domain. Similar barriers were grouped, and subthemes were created. Main actors mentioned in the literature (researchers, editors, and funders) were associated with these barriers. To code and classify strategies proposed by authors to increase use and conduct of replication research, the behavior change wheel (BCW) was used [20]. The BCW identifies nine intervention functions and seven policy options that can be selected to facilitate practice or behavior change and lead to the adoption of a targeted behavior [20]. Data extracted describing strategies were coded and grouped to create subthemes. Each strategy found was classified according to its targeted actor(s) and was then associated with one or multiple intervention functions or policy categories

from the BCW. Results obtained following the analysis of papers included from the first literature search were discussed with the research team during a consensus meeting to ensure appropriateness of the data analysis process. Results for the updated search were coded using the same tree codes and new codes were created when required.

3. Results

One hundred fifty-three papers were included in the original meta-narrative review [4]. Manuscripts are mostly conceptual papers (54%), original studies (18%), editorials/opinion papers (15%), methods papers (8%), and literature reviews (5%). Of the original studies, four used survey methods to document journal editors attitudes toward replication research in education [21], social sciences [22,23], and business [24]. One study also used a questionnaire to document computing education researchers attitudes toward replication research [25]. Thus, barriers and strategies reported in this paper are primarily based on the perceptions and opinions of their authors who have written and reflected on the relevance and importance of this subject.

3.1. Barriers to replication research

Information on barriers to replication was extracted from 91 of the 152 papers. Barriers found were classified under 9 of the 14 TDF domains. No barriers were classified under five domains (social/professional role and identity, beliefs about capabilities, intention, memory, and behavioral regulation). Table 1 presents subthemes that were identified within each of the nine TDF domains and to which actors (researchers, editors, or funders) these barriers apply. For researchers, their scientist and professor/teaching roles (mentoring new trainees, teaching research, etc.) were both considered. Editors were defined as the one responsible for monitoring and ensuring the scientific journal peer-review editorial process [26]. They have multiple responsibilities toward authors, peer reviewers, journal's readers, publishers, and the public to ensure the scientific quality of published articles. Funders are organizations responsible of providing research funding such as research councils, universities, or foundations.

3.1.1. Knowledge

Researchers, journal editors, and funders were all described in papers as lacking knowledge on replication research. They were described as sharing a misconception that replication refers exclusively to the exact or strict repetition of a previous study and to the widespread belief that many studies cannot be replicated because context cannot be duplicated [5,27–29]. This misconception was explained by a lack of clarity of the subject in the research literature, its scant treatment in research methods textbook, an absence of agreement on a classification or on

definitions of different replication types, and a misunderstanding of the role of replication in the research process [6,27,30–35].

3.1.2. Skills

Researchers were mentioned to lack skills to design replication studies and to interpret their findings [27,36,37]. This lack of skills may not lead them to explicitly identify their study as a replication [6,10]. Journal editors and reviewers were also considered to lack skills to evaluate the quality of these studies [38,39] and to interpret replication research findings [39].

3.1.3. Optimism

Researchers were described to have low motivation to conduct a replication because it is considered as an inferior task [5]. They expect that replications will be considered not publishable even if they are well conducted studies [5,6,22,25,29,40]. Furthermore, if the replication study does not confirm the index study findings, they think results of the replication will be ignored because original research is rarely suspected to be flawed [27]. They also perceive that the burden of proof lies with the researcher attempting to replicate and that they face the challenge of convincing reviewers of the importance and potential scientific impact of these results [27,41]. To divert this situation, it is possible that researchers conducting replications do not explicitly refer to them as such due to the perception that they are not prestigious [10].

3.1.4. Beliefs about consequences

Some authors reported that researchers fear that doing this kind of research can involve social and career related risks because scientists who conduct replications are considered lacking creativity and originality [14,23]. Researchers worry about being in an unfortunate position if they fail to replicate by harming the reputation of original study authors but also about receiving threats and personal attacks of incompetence by the index study authors [14,23,29,33,42].

3.1.5. Reinforcements

The reward system in the scientific world is believed to support and favor original research [43,40]. Editors and reviewers are perceived to be reluctant to publish replication studies and hold biases against replication [7,22,27,28,33,44]. When reviewing replication studies, editors are faced with the dilemma of publishing results of a study that confirm previous published results, which appear to be uninteresting, or results of a study conflicting previous results, which are often seen as an artifact or flaw [45]. Funding agencies also favor original studies to replications with grant review criteria emphasizing innovative research [25,31,37,41,46,47].

Table 1. Barriers to replication research by different stakeholder groups

Barriers to replication research	Researchers/professors	Editors	Funders
Knowledge			
• Misconceptions of replication which is often understood to consist of strict replication	X	X	X
• Lack of conceptual clarity in the literature	X	X	X
• Lack of understanding of replication purposes and usefulness	X	X	X
• Overgeneralization of single study results	X	X	X
• Misinterpretation of the concept of originality	X	X	X
Skills			
• Lack of skills to design replication studies	X		
• Lack of methodological training	X	X	
• Lack of skills to interpret replication research findings	X	X	
• Lack of editors' skills to review and evaluate the quality of replication studies		X	
Optimism			
• Assumption that results of a replication study will not be published	X		
• Burden of proof to demonstrate importance and relevance of replication results lies with person attempting to replicate	X		
Beliefs about consequences			
• Fear of social and career-related risks	X		
• Fear of exposing original study flaws	X		
• Fear to impute the reputation of original study authors	X		
Reinforcement			
• Reward structure in scientific world values original research		X	
• Editors and reviewers have a bias against replication		X	
• Funding agency programs favor original and innovative research			X
Goals			
• Replication provides limited opportunity for promotion, tenure, publication, and funding	X		
• Publication of replication studies can have a negative impact on readership and journal impact factor		X	
Environmental context			
• Poor reporting of original research	X		
• Lack of validated measurement tools can make certain types of replication difficult	X		
• No substantive guidelines available to support the conduct of replication research	X	X	
• Confidentiality agreements limit data sharing	X	X	
• Limited journal space	X	X	
• Lack of systems and policies to facilitate data sharing			
• Lack of specific funding for replication			X
Social influences			
• Scientific culture that values positive results	X	X	X
• Replication is not recognized as a valuable research activity	X	X	X
• Graduate students and new scientists are not sufficiently aware of the importance of replication	X		
• Editors and reviewers prefer publishing original and positive study results		X	
Emotions			
• Fear of attacking another researcher	X		
• Fear to impute the reputation of original authors	X		
• Reluctance to share data due to fear the replication will show false results	X		
• Excessive emphasis on detecting false or fake results	X		
• Fear to be perceived by a lack of trust in colleagues	X		

3.1.6. Goals

Researchers express low motivation to conduct replication research. They are reported to be reluctant to conduct research activities which lack credibility and appear to provide limited opportunity for recognition, credit, publication, promotion, and tenure processes, obtaining citations and funding at the volume expected by their peers [5,9,23,25,31,32,48,49]. Scientists share the belief that such research is not competitive or valuable to their career development compared to conducting original research [25,41,50]. As mentioned by Neuliep and Crandall [22], because “publish or perish” is a concern in academics, individual researchers would have to think twice about carrying out replication studies. Journal editors are reported to base publication decisions on creativity, originality, and new innovative research findings [5,40,41,51] to maintain readership and high impact factor [14].

3.1.7. Environmental context

Authors identified that some essential conditions are not respected for researchers to conduct replication: there is poor reporting of original research methods, analysis, and incomplete description of intervention content and delivery [5,12,25,28,36,37,39,42,49,52–54]. Lack of validated measurement tools and their inconsistent use can also limit researchers’ ability to replicate a published study [49]. They also reported it being difficult to engage in data sharing because scientists have to respect ethics committee requirements and confidentiality agreements [7,47,55,56]. Some authors described how lack of journal space for publishing results [49,54], lack of systems and policies to facilitate data sharing between researchers [7,9,40,47,48], lack of journals devoted to replication studies may discourage editors from publishing replication studies [11]. Multiple papers reported the absence of substantive publishing and authors’ guidelines that would support, facilitate, and promote replication [11,31]. There is also a lack of funding to replicate costly studies such as large randomized controlled trials [9,30].

3.1.8. Social influences

Researchers, editors, and funders all lack interest in replication because it is considered as not bringing new findings [11,27,31,32]. Culturally, they value original and innovative research [23,37,49]. There is also a misinterpretation of the concept of originality that discourages replication because originality is usually understood as conducting a new study on a different subject instead of being the requirement to make an original contribution to the body of knowledge [5,31]. This leads to an overemphasis on novelty and to the focus of research being most of the time reserve to idea generation at the expense of idea evaluation [9]. Researchers and graduate students were mentioned to lack training to conduct replication studies [44]. Faculty may pass on this belief that replication studies are somehow inferior to their graduate students [30,32,37,49,57]. They

work independently and competition for funding and for publishing contributes to maintaining social conformity and pressure to conduct new investigations [31]. Authors stated that editors and journal publication policies clearly prefer to publish new striking research and often devalue methodologically rigorous studies with statistically insignificant results and replication studies [44,58,59]. The quantity of replication is probably influenced by the extent to which journals encourage or discourage replication [12]. Furthermore, publishing bias in favor of positive findings is also reported to limit the amount of replication studies being accepted for publication [22,60,61].

3.1.9. Emotions

Some authors revealed that researchers express negative emotions with regards to replication: fear of attacking or lacking trust in another researchers [28] or fear to impute someone’s reputation [42]. They are also reluctant to share data and methodology that could reveal errors or false results or program codes to which they spent a lot time developing [37,48,62]. They worry that their work would not be recognized at the level of the effort invested in methods and data collection if other researchers just warrant citation of their study and do not provide co-authorship on paper using previously collected data to conduct a replication [55].

3.2. Solutions to improve use of replication

Multiple solutions associated with different intervention functions were suggested in 67 of the 153 included papers to improve the conduct, publishing, and funding of replication research (Table 2).

3.2.1. Solutions for all actors

First, some recommendations concerned the education of all actors to enhance understanding of what replication is, its multiple purposes, and its range of designs. A potential strategy identified was to establish a consortium or a professional society that would contribute to design a physical and social research environment appropriate for replication [11,14]. This group of researchers, editors, funders, academics, and knowledge users could engage in a critical dialogue about the utilization of replication in research and develop educational material and guidelines for the appropriate reporting of original studies and the planning and conduct of multiple types of replication studies [12,30,62]. They could also organize workshops, conferences, and summer institutes on how to conduct replications [11,14].

3.2.2. Solutions for researchers

Recommendations for researchers focused on training, persuasion, restriction, and enablement. The case was made for providing education and training to improve researchers’ knowledge and skills to plan and conduct replication studies [40,44]. Researchers holding an academic

Table 2. Strategies proposed by authors to improve use of replication

Intervention functions	Ed	Train	Mod	Coer	Inc	Pers	Enab	Env	Rest	Guid	Reg	EnvSoc
For all actors												
Enhancing general understanding of replication research	✓											
Developing of a consortium dedicated to replication	✓	✓					✓	✓				✓
Researchers												
Developing a framework or guidelines to elaborate and plan the conduct of replication studies	✓							✓				
Teaching replication methods courses to graduate students	✓					✓		✓				
Providing opportunities to graduate students to conduct replication		✓				✓	✓					
Following better publishing standards			✓			✓		✓		✓		
Committing to share original data, including data repository						✓						
Collaborating with index study authors in designing replication studies							✓					
Encouraging researchers to identify replication study as such					✓	✓						
Including replication studies within research program							✓		✓			
Editors												
Dedicating space or devoting special issue to replication research							✓	✓				
Exhorting senior researchers to conduct replication studies			✓		✓		✓					
Identifying important studies that should be replicated			✓				✓					
Ensuring replication research methods expertise on editorial board and peer review panel		✓						✓				
Appointing a replication editor								✓				
Promoting use of reporting guidelines												
Providing space for study details, appendix, and data archiving								✓				
Developing policies about publishing replication studies including data archiving and sharing as a condition for publication				✓				✓			✓	
Funders												
Dedicating funding sources to replication studies					✓		✓	✓				
Requesting data sharing plan in funding proposal				✓	✓		✓	✓				
Commissioning replication studies in specific research fields					✓		✓	✓				

Abbreviations: Ed, Education; Train, Training; Mod, Modeling; Coer, Coercion; Inc, Incentivization; Pers, Persuasion; Enab, Enablement; Env, Environmental restructuring; Rest, Restrictions; Guid, Guidelines; Reg, Regulation; EnvSoc, Environmental/Social Planning.

position were also called upon to expose graduate students and young investigators to replication methods [11,28,32,36,37,42,63,64] by using education, modeling, persuasion, and enablement. They should encourage graduate students to conduct replication studies [14,27], as part

of their training and include replication methods in their graduate studies curriculum [11,14,63].

Authors identified several other potential strategies for researchers aimed at increasing the opportunity to replicate published index studies such as first, adhering to better

publishing standards (detailed reporting of background, interventions, methods, limitations, or threats to external validity, requirement to substantiate previous related findings and situate new findings in prior research) [7,14,15,30,37,41,46,49,52,55,65–69]. Second, sharing data in a readily useable fashion should, when it is possible, become a standard practice [12,14,48,55,70–72]. Third, index study researchers should accept to collaborate with teams replicating their study to provide appropriate documentation and discuss implications of the replication results especially when there is a failure to replicate [12,33,70,73]. Fourth, scientists should be encouraged to proudly identify their study as a replication and clearly cite previous studies [12,40,44,68,74]. Finally, multiple authors also suggest there should be a new social norm requiring that a proportion or ratio of every researcher activities consist of replication studies every year as part of their research program [12,14,55,70,73].

3.2.3. Solutions for journal editors

For journal editors, some suggested strategies aim at environmental restructuring by providing more opportunities to publish replication results such as dedicating space or devoting a special issue to replication studies [2,7,11,33,37,40,42,63,64,70,71,75–77]. Interestingly, some authors describe that editors can promote behavior modeling to increase the appropriate use of replication by, for example, encouraging senior and renowned researchers to conduct replication studies [12,40,70] or by identifying studies that are considered important to replicate [7,15,66]. Editors should also be trained to have the required skills to review replications and recognize their importance for knowledge development [12,15,66]. Some authors suggested that journals could appoint a replication editor or an editorial board devoted to replication [7,42,66]. Still others stated that it is also important to promote use of adequate reporting guidelines and submission of detailed appendices including experimental protocol, instructions to subjects, measurement tools, and so on [28,49,52,78].

At a policy and regulation level, some authors described that publishers should have stated replication guidelines [12,14,15,37,53,56,79,80] and publishing policy requirements for data archiving and data sharing before publication [7,12,42,48]. Managing the archive was recommended to be an editorial function [71].

3.2.4. Solutions for funders

Suggestions formulated for funders targeted environmental restructuring, incentivization, and enablement. Authors proposed that funders increase opportunities by dedicating funding sources to replication studies, by commissioning replication studies in specific fields and funding high-quality applications for replication studies [11,14,15,37,64]. Coercion and incentivization to create conditions facilitating replication, such as requesting a data sharing plan in funding proposals or imposing a new

condition for receiving a grant whereby an amount of the grant should be spent on replicating key findings in one's field, were also suggested as strategies funders could use [14,48].

4. Discussion

Multiple barriers limit the conduct of replication research. Researchers' behavior about replication can be explained by multiple inter-related factors mostly from the TDF domains of social influences, environmental context, reinforcement, knowledge, and skills domains. For researchers, if they are expected to develop new, creative, and original research to get funded, published, and promoted, there is not much chance that they will decide, without any changes in the social and physical environment, to conduct replication studies or encourage their students to do so. These informal social norms are shared by researchers, funders, and editors and are maintained even if multiple authors have called for the necessity of more replication [1,11,81]. Based on the barriers reported in the literature, it appears that to change this behavior, rules and expectations will need to change at the community level and opportunities for replication will need to be provided. Structures to facilitate data sharing and access to protocols, intervention description, measurement tools used in index studies should be established. As described by Resnik et al. [82], scientific journals made considerable progress in the last years to implement data sharing policies. However, after reviewing the conditions of publication of 447 journals across multiple scientific disciplines, they found that only a very small percentage of these journals required data sharing. Improvement of these structures need to create reinforcement “for” instead of “against” the behavior and will demonstrate that replication of an index study from another investigator is an appropriate, valued, and recognized research activity. Lack of knowledge and skills to conduct and assess replication studies will need to be addressed simultaneously to develop positive beliefs about consequences within the research community.

Suggestions extracted from the papers included in this review addressed many of the barriers. They were found to be more frequently associated with two BCW interventions functions: enablement and environmental restructuring. Offering opportunities for researchers to develop the intention to conduct replication studies is important [13]. Incentives can be provided by editors and funders who hold the power to decide what kind of research should be funded and published [12,13,15]. Some strategies were also identified to be related to policy categories such as guidelines, regulation, and environmental/social planning. For example, it was recommended that a consortium, composed of well-known and established scientists, editors, and funders, should be established and be responsible of developing guidelines, making recommendations and exerting

a positive influence and leadership on the organizations responsible of research governance [11,14]. An example of such a group is the UK Reproducibility Network [83]. These results suggest that strategies to improve the use of replication research should aim at changing a social and community behavior and not only individual researcher behavior [12,14,15,56]. Strategies that were classified under the education, training, modeling, and incentivization behavior functions were also formulated in terms of changing group attitudes, creating positive outcomes expectations, and reinforcement toward replication.

The “Social Change Theory,” developed by Thompson and Kinne [84], provides a useful framework to understand the lack of utilization of replication in research and support the identification of the mechanisms likely to change this social behavior. The Social Change Theory argues that large-scale behavioral change is best achieved by changing the standards of acceptable behavior in a community. The assumptions underlying this theory are that social change is preceded or followed by changes in the normative structure of a system. It occurs when parts of the system break down or when environmental changes overwhelm the system. Social norms change along with the system to provide new rules of conduct to help maintain the reform system. Change is produced by collective action or social movements or by external forces in the form of laws and policies to influence norms and values within the system. Individuals, because they interact with the system, are subjected to change norms and practices and these new norms can be reinforced by role models. Diffusion of new information can influence individual decisions and expectations of others. The interrelationships between changes happening at different levels support the adoption of the new norms and facilitate the widespread of individual change.

Based on this theory, the change required to increase use of replication can start by collective actions that should arise and take the form, for example, of advisory groups, including researchers, editors, and funders, within different research networks [11,14,15]. These groups can exert influence on research funding agencies and journal editors, change the research environment, and provide the structures, resources, and incentives required for planning and conducting replication studies. Advisory groups could take a leadership role and develop educational material that could be incorporated into higher education curriculums, publication guidelines, and funding programs. Researchers within these groups can act as role model by conducting themselves replication studies, suggesting how their study should be replicated and for what purpose, or by pointing out important studies or research topics in need of replication. These simultaneous actions can progressively influence everyone’s behavior by changing their conceptual understanding of what replication is and why it is important for the sound development of knowledge.

Strengths of this review were the inclusion of 152 papers from multiple research fields. Nevertheless, most of the included papers are conceptual and report the views and opinions of their authors but not evidence of assessed barriers or effectiveness of the multiple recommended strategies. The use of the TDF and the BCW to organize data extracted facilitated the comparison between barriers and strategies suggested. However, use of another framework having a lesser focus on individual determinants of change, for example, the Consolidated Framework for Implementation Research [85], could have provided another picture by placing more emphasis on organizational and contextual factors [86]. One limitation of this study was that only one reviewer extracted the data from each included paper. Reliability checks were performed on approximately 10% of the papers. A second limitation concerns the updated search conducted to retrieve relevant papers published between 2014 and 2018. Because our team decided to conduct a forward search of the most cited included papers, this may have led our team to miss some recent published papers. Nevertheless, we observed that described barriers and solutions found in the literature from multiple research fields were similar between papers and this increased our confidence in the representativeness of this review results.

5. Conclusion

Replication research is important to improve credibility and generalizability of research findings. However, based on this narrative review, few progresses were made in the last 40 years to address replication barriers except for the development and increase use of reporting guidelines and data sharing and archiving requirements. A social change involving multiple research actors in advisory groups, research organizations, and institutions is required to establish new norms that will value, promote, support, and reward replication research.

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Supplementary data

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